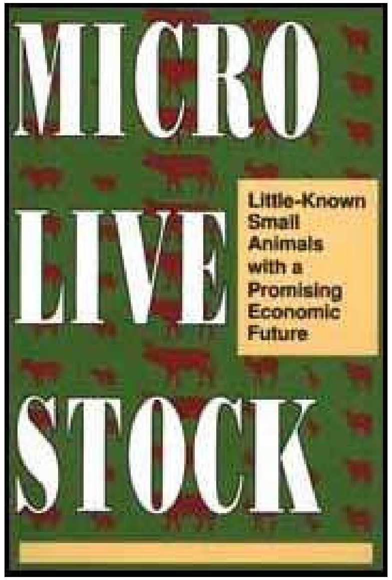

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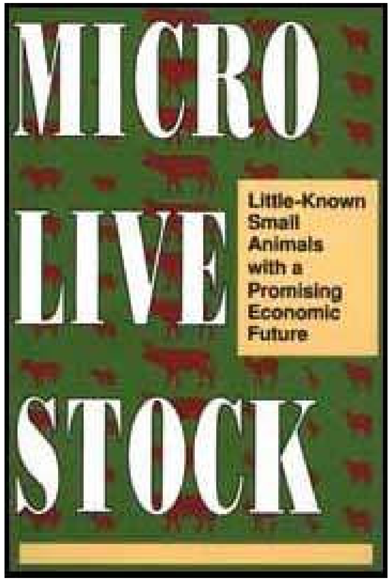

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NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competence and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the

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PANEL ON MICROLIVESTOCK

RALPH W. PHILLIPS, Deputy Director General (Retired), Food and Agriculture

Organization of the United Nations, Chairman
EDWARD S. AYENSU, Senior Advisor to the President, African Development Bank, Abidjan, Ivory Coast.
BONNIE V. BEAVER, Professor of Veterinary Medicine, Department of Small Animal Medicine and Surgery, Texas A&M University, College Station, Texas, USA
KURT BENIRSCHKE, Professor of Pathology and Reproductive Medicine, University of California-San Diego, San Diego, California, USA
ROY D. CRAWFORD, Professor of Animal and Poultry Genetics, Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
TONY J. CUNHA, Distinguished Service Professor Emeritus, University of Florida, Gainesville, and Dean Emeritus, School of Agriculture, California Polytechnic University, Pomona, California, USA
DAVID E. DEPPNER, Director, New Forest Project, International Center, Washington, D.C., USA
ELIZABETH L. HENSON, Executive Director, American Minor Breeds Conservancy, Pittsboro, North Carolina, USA
DONALD L. HUSS, Menard, Texas, USA (Formerly Regional Animal Production Officer, FAO, Santiago, Chile)
DAVID R. LINCICOME, Guest Scientist, U.S. Department of Agriculture, Beltsville, Maryland, USA
THOMAS E. LOVEJOY, Assistant Secretary for External Affairs, Smithsonian Institution, Washington, D.C., USA
ARNE W. NORDSKOG, Professor Emeritus, Department of Animal Science, Iowa State University, Ames, Iowa, USA
LINDA M. PANEPINTO, Director, Miniature Swine Laboratory, Colorado State

University, Fort Collins, Colorado, USA
KURT J. PETERS, Professor of Animal Breeding and Husbandry in the Tropics and Subtropics, University of Gottingen, Gottingen, West Germany, and Director of Research, International Livestock Centre for Africa, Addis Ababa, Ethiopia
JOHN A. PINO, Senior Fellow, National Research Council, Washington, D.C., USA
HUGH POPENOE, Director, International Program in Agriculture, University of Florida, Gainesville, Florida, USA
MICHAEL H. ROBINSON, Director, National Zoological Park, Washington, D.C., USA
KNUT SCHMIDT-NIELSON, James B. Duke Professor of Physiology, Department of Zoology, Duke University, Durham, North Carolina, USA
ALBERT E. SOLLOD, Associate Professor and Head, Section of International Veterinary Medicine, Tufts University, North Grafton, Massachusetts, USA
LEE M. TALBOT, Visiting Fellow, World Resources Institute, Washington, D.C., USA
CLAIR E. TERRILL, Sheep and Goat Scientist, U.S. Department of Agriculture, Beltsville, Maryland, USA
CHRISTEN M. WEMMER, Assistant Director for Conservation, National Zoological Park, Front Royal, Virginia, USA
DANNY C. WHARTON, Associate Curator Animal Departments, New York Zoological Park, Bronx Zoo, The Bronx, New York, USA
CHARLES A. WOODS, Professor and Curator, Florida State Museum, University of Florida, Gainesville, Florida, USA
THOMAS M. YUILL, Associate Dean for Research and Graduate Training, School of Veterinary Medicine, University of Wisconsin-Madison, Madison, Wisconsin, USA

*** * ***

NOEL D. VIETMEYER, Board on Science and Technology for International

Development (BOSTID), National Research Council, Washington, D.C., Microlivestock Study Director and Scientific Editor

NATIONAL RESEARCH COUNCIL STAFF
F.R. RUSKIN, BOSTID Editor
MARK DAFFORN, Technical Writer
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CONTRIBUTORS

The following individuals have made general contributions to the development of this book. All of the persons listed as research contacts in Appendix B also contributed - usually on one or two species that are their scientific specialty.

ASHIQ AHMAD, Wildlife Management Specialist, Pakistan Forest Institute, Peshawar, Pakistan
ANGEL C. ALCALA, Division Research, Extension and Development, Silliman University, Dumaguete City, Philippines
HARTI AMMANN, Basel, Switzerland
PATRICK ANDAU, Forest Department, Sandakan, Sabah, Malaysia
S.P. ARORA, National Dairy Research Institute, Karnal, India
S. AYYAPPAN, CIFRI, Kausabyaganga, Bhubaneswar Orissa, India
WALTER BAKHUIS, Caribbean Marine Biological Institute, Willemstad, Curacao, Netherlands Antilles
JAMES R. BARBORAK, CATIE, Turrialba, Costa Rica

PUSHKAR NATH BHAT, Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh, India
STEVE BENNETT, Curepe, Trinidad, West Indies
K.P. BLAND, Department of Physiology, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Edinburgh, Scotland
MELVIN BOLTON, Yeppoon, Queensland, Australia
JOSEPH BONNEMAIRE, Ecole Nationale Superieure des Sciences Agronomiques Appliquees, Dijon, France
R.D.S. BRANCKRAERT, Faculte des Sciences Agronomiques, Universite du Burundi, Bujumbura, Burundi
PETER BRAZAITIS, Herpetology, New York Zoological Society, The Bronx, New York, USA
L. DE LA BRETONNE, JR., Louisiana Cooperative Extension Service, Louisiana State University, Baton Rouge, Louisiana, USA
P. BRINCK, Department of Animal Ecology, University of Lund, Lund, Sweden
LESLIE BROWNRIGG, CIAT, Cali, Colombia
D. HOMER BUCK, Illinois Natural History Survey, Kinmundy, Illinois, USA
GERARDO BUDOWSKI, Natural Renewable Resources Programme, CATIE, Turrialba, Costa Rica
DAVID BUTCHER, Taronga Zoo, Mosman, New South Wales, Australia
JULIAN O. CALDECOTT, World Wildlife Fund Malaysia, Kuching, Sarawak, Malaysia
GARY CALLIS, Texline, Texas, USA
J.K. CAMOENS, Asian Development Bank, Manila, Philippines
A. CHRISTOPHER CARMICHAEL, The Museum, Michigan State University, East Lansing, Michigan, USA
ROBERT H. CHABRECK, School of Forestry and Wildlife Management, Louisiana

State University, Baton Rouge, Louisiana, USA
A.M. CHAGULA, Research, Ministry of Agriculture, Dar-es-Salaam, Tanzania
CHARAN CHANTALAKHANA, Department of Animal Science, Kasetsart University, Bangkok, Thailand
PETER R. CHEEKE, Rabbit Research Center, Oregon State University, Corvallis, Oregon, USA
G.S. CHILD, Forest Resources Division, FAO, Rome, Italy
A.S. CHOPRA, Ministry of Agriculture, Department of Agriculture and Cooperation, New Delhi, India
W. Ross COCKRILL 29 Downs Park West, Bristol, England, BS6 7QH
CRISOSTOMO CORTES, Dairy Promotion and Extension Section, Dairy Development Division, Manila, Philippines
WYLAND CRIPE, College of Veterinary Medicine, University of Florida, Gainesville, Florida, USA
A. BEN DAVID, Holon, Israel
C. DEVENDRA, International Development Research Centre, Singapore
RODNEY DILLINGER, International Agency for Apiculture Development, Rockford, Illinois, USA
DIRECTOR, Natal Parks Board, Pietermaritzburg, South Africa
ROLLANDE DUMONT, Ecole Nationale Superieure des Sciences Agronomiques Appliquees, Dijon, France
N.G. EHIOBU, Department of Agricultural Sciences, College of Education, Agbor, Nigeria
DONALD FARNER, Department of Zoology, University of Washington, Seattle, Washington, USA
JOHN A. FERGUSON, Overseas Development Administration, Eland House, London,

England
ABELARDO FERRER D., Quinta Nueva Exparta, San Bernardino, Caracas, Venezuela
LYNWOOD A. FIEDLER, Section of International Programs, U.S. Fish and Wildlife Service, Denver Wildlife Research Center, Denver, Colorado, USA
H. FISCHER, Tropical Science Centre, Division of Tropical Veterinary Medicine, Justus-Liebig University, Giessen, West Germany
J. FURTADO, Commonwealth Science Council, London, England
FRANK GOLLEY, Institute of Ecology, University of Georgia, Athens, Georgia, USA
E. GONZALES J., Instituto de Produccion Animal, Universidad Central de Venezuela, El Limon-Maracay, Venezuela
GRAHAM GOUDIE, Mainland Holdings, Lae, Papua New Guinea
ALISTAIR GRAHAM, Tanglewood, Crowborough, East Sussex, England
GORDON GRIGG, Zoology, University of Sydney, Sydney, New South Wales, Australia
M.R. DE GUMAN, JR., Food and Fertilizer Technology Center, Taipei, Taiwan
COLIN P. GROVES, Department of Prehistory and Anthropology, The Australian National University, Canberra, ACT, Australia
J. HARDOUIN, Institut de Medicine Tropicale "Prince Leopold," Antwerp, Belgium
GEOFFREY HAWTIN, International Development Research Centre, University of British Columbia, Vancouver, B.C., Canada
GORDON HAVORD, Technical Advisory Division, UNDP, New York, New York, USA
TIN HLA, Veterinary Department, Director General's Office, Rangoon, Burma
JAMES HENTGES, Department of Animal Science, University of Florida, Gainesville, Florida, USA
W.F. HOLLANDER, Department of Genetics, Iowa State University, Ames, Iowa, USA

RENE E. HONEGGER, Herpetology, Zurich Zoo, Zurich, Switzerland
JACK HOWARTH, School of Veterinary Medicine, University of California, Davis, California, USA
HUANG CHU-CHIEN, Institute of Zoology, Academia Sinica, Beijing, China
ANGUS HUTTON, Gympie, Queensland, Australia
H.A. JASIOROWSKI, Animal Production and Health Division, FAO, Rome, Italy
MUHAMMAD YAQUB JAVAID, Directorate of Fisheries, Government of the Punjab, Punjab, India
J. MANGALARAJ JOHNSON, Nudumalai Sanctuary, Vannarpet, Udagamandalani, India
MATI KAAL, Tallinn Zoo, ESSR Tallinn, USSR
STELLAN KARLSSON, Simontorp Aquaculture AB, Blentarp, Sweden
JACKSON A. KATEGILE, International Development Research Centre, Nairobi, Kenya
ROBERT E. KENWARD, Institute of Terrestrial Ecology, Furzebrook Research Station, Wareham, Dorset, England
JAMES M. KEARNEY, Miami, Florida, USA
F. WAYNE KING, Florida State Museum, Gainesville, Florida, USA
H.-G. KLOS Zoologischer Garten Berlin, Berlin, West Germany
NELS M. KONNERUP, Boom International, Stanwood, Washington, USA
NAVU KWAPENA, Office of Environment and Conservation, Boroko, Papua New Guinea
THOMAS E. LACHER, Huxley College of Environmental Studies, Western Washington University, Bellingham, Washington, USA
JOHN K. LOOSLI, Gainesville, Florida, USA
PETER LUTZ, Rosenstiel School of Marine and Atmospheric Science, University of

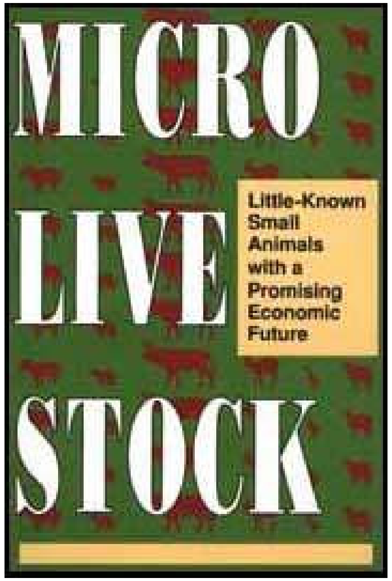
Miami, Miami, Florida, USA
CRAIG MACFARLAND, CATIE, Turrialba, Costa Rica
CONSTANCE M. MCCORKLE, Department of Rural Sociology, University of Missouri, Columbia, Missouri, USA
ROBERT E. MCDOWELL, Department of Animal Science, Cornell University, Ithaca, New York, USA
JEFFREY A. MCNEELY, International Union for Conservation of Nature and Natural Resources, Gland, Switzerland
ADRIAN G. MARSHALL, Institute of South-East Asian Biology, University of Aberdeen, Aberdeen, Scotland
RICHARD R. MARSHALL, Veterinary Medicine, Sutter Hospitals Medical Research Foundation, Sacramento, California, USA
G.H.G. MARTIN, Department of Zoology, Kenyatta University College, Nairobi, Kenya
IAN L. MASON, Edinburgh, Scotland
JOHN C. MASON, Pacific Biological Station, Nanaimo, B.C., Canada
J. MAYO MARTIN, Fish Farming Experimental Station, Stuttgart, Arkansas, USA
YOLANDA MATAMOROS, Escuela de Medicina Veterinaria, Universidad Nacional, Heredia, Costa Rica
ROBIN MCKERGON, Livestock Development Corporation, Lae, Papua New Guinea
M. MGHENI, Faculty of Agriculture, Sokoine University of Agriculture, Morogoro, Tanzania
P. MONGIN, Station de Recherches Avicoles, INRA-Centre de Tours, Nouzilly, Monnaie, France
JOSE ROBERTO DE ALENCAR MOREIRA, Agricultural Research Center of the Humid Tropics, Belem, Para, Brazil

W.L.R. OLIVER, Jersey Wildlife Preservation Trust, Jersey, Channel Islands, United Kingdom
WERNER PAUWELS, Basel, Switzerland
W.J.A. PAYNE, Worcester, England
IAN PLAYER, Wilderness Leadership School, Bellair, Natal, South Africa
JAMES H. POWELL, JR., Plainview, Texas, USA
WILLIAM R. PRITCHARD, School of Veterinary Medicine, University of California, Davis, California, USA
HECTOR HUGO LI PUN, International Development Research Centre, Bogota, Colombia
VICENTE T. QUIRANTE, Small Ruminant Collaborative Research Project, Bureau of Animal Industry, Manila, Philippines
DAN RATTNER, The Institute of Animal Research, Kibbutz Lahav, D.N. Negev, Israel
C.V. REDDY, Faculty of Veterinary Science, Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad, India
RHOEHEIT, Institute of Applied Science and Technology, University Campus, Turkeyen, Guyana
CHARLES T. ROBBINS, Department of Zoology, Washington State University, Pullman, Washington, USA
CARMEN MA. ROJAS G., CATIE, Turrialba, Costa Rica
D.H.L. ROLLINSON, Sardinia, Italy
JULIO E. SANCHEZ P., Museo Nacional, San Jose, Costa Rica
JEFF SAYER, World Conservation Centre, Gland, Switzerland
G. SEIFERT, Tropical Cattle Research Centre, CSIRO, Rockhampton, Queensland, Australia

ANDRES ELOY SEIJAS, Servicio Nacional de Fauna Silvestre, Maracay, Venezuela
S.K. SHAH, Institute of Animal Sciences, National Institute of Health, Islamabad, Pakistan
SIEH CHENXIA, Department of Animal Science, Nanjing Agricultural College, Nanjing, People's Republic of China
B.P. SINGH, College of Veterinary and Animal Science, Chandra Sekhar Azad University of Agriculture and Technology, Mathura, Uttar Pradesh, India
C. CATIBOG SINHA, Forest Research Institute, College, Laguna, Philippines
A.J. SMITH, Tropical Animal Health, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Edinburgh, Scotland, Great Britain
A. MITHAT EFENDI, Ankara, Turkey
HENRY STODDARD, Shamrock Veterinary Clinic and Fisheries, Cross City, Florida, USA
SUKUT SULARSASA, Faculty of Animal Husbandry, Gadjalu Mada University, Yogyakarta, Indonesia
D.L. SUTTON, Agricultural Research and Education Center, Fort Lauderdale, Florida, USA
NICHOLAS SMYTHE, Smithsonian Tropical Research Institute, Panama
J. SZUMIEC, Polish Academy of Sciences, Experimental Fish Culture Station, Chybie, Poland
N. TABUNAKAWAI, Ministry of Primary Industries, Suva, Fiji
FRANK M. THOMPSON, Wild Animal Brokers, Bradenton, Florida, USA
ALLEN D. TILLMAN, Stillwater, Oklahoma, USA
DON TULLOCH, Winnellie, Northern Territory, Australia
CONRADO A. VALDEZ, Dairy Development Division, Bureau of Animal Industry, Manila, Philippines

LUIS VARONA, Havana, Cuba
PRAN VOHRA, Department of Avian Sciences, College of Agricultural and Environmental Sciences, University of California, Davis, California, USA
ANTOON DE VOS Whitford, Auckland, New Zealand
GRAHAME WEBB, Conservation Commission of the Northern Territory, Winnellie, Northern Territory, Australia
DAGMAR WERNER, Fundacion Pro Iguana Verde, Heredia, Costa Rica
GARY WETTERBERG, Department of the Interior, Washington, D.C., USA
CHARLES H. WHARTON, Clayton, Georgia, USA
F.W. BERT WHEELER, College Station, Texas, USA
ROMULUS WHITAKER, Madras Crocodile Bank, Perur, Tamil Nadu, India
WILDLIFE CONSERVATION INTERNATIONAL, New York Zoological Society, The Bronx, New York, USA
R.R. YEO, USDA-ARS, University of California, Davis, California, USA
BRUCE A. YOUNG, Department of Animal Science, University of Alberta, Edmonton, Alberta, Canada
CHAROON YOUNGPRAPAKORN, The Samutprakan Crocodile Farm and Zoo, Samutprakan, Thailand
THOMAS M. YUILL School of Veterinary Medicine, University of Wisconsin, Madison, Madison, Wisconsin, USA
W. ZEILLER, Miami Seaquarium, Miami, Florida, USA

Micro-livestock: Little-known Small Animals with a Promising Economic Future (BOSTID, 1991, 435 p.)
Part VII Others



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Part VII Others

As noted in the preface, this report by no means exhausts all the microlivestock possibilities. Lack of space and time precludes discussion of creatures such as edible insects, snails, worms, frogs, turtles, and bats, which in some regions are highly regarded foods. Similarly, we have not included fish, shrimp, and other aquatic life.

This is not to say that these are less worthy of consideration. The decision to leave them out was arbitrary, but with several recent breakthroughs in tropical beekeeping it seems prudent to include bees. Accordingly, the final chapter of this book describes the smallest livestock of all.

Bees are one of the most promising microlivestock. They forage on flowers that are otherwise little utilized and produce honey, wax, and other products of high value. They are important as plant pollinators and can greatly increase the production of some crops. Bees can be kept virtually anywhere with little disruption of other activities, and they are easily available.

35 Bees

FIGURE

Of all the livestock reviewed in this publication, bees are the smallest, the least demanding of space, probably the most familiar, and perhaps the most easily adapted to worldwide rural development efforts. For all that, however, they are an often forgotten component in agricultural programs. This is unfortunate because bees can be particularly valuable to tropical countries, providing pollination of crops, useful products, and a premium source of income.

Almost every village in every tropical country traditionally has had a beekeeper or two. Most use "seat-of-the-pants" methods and "rustic" hives, and this generally leads to low yields and inefficiencies. Today, numerous innovative methods and appropriate equipment are coming available. Many are still not widely known; however, their importance is slowly being recognized. Indeed, some developing countries are already turning bees into a valued natural resource.

For example, in less than 10 years Kenya has become self-sufficient in honey production and - despite increased local consumption - is now exporting. In seven years, Papua New Guinea has met its local honey requirements and now also exports its surplus. In only four years, Thailand increased yearly production from practically nothing to more than 1,000 tons. In Brazil, beekeeping is more widespread and production greater than before the outbreak of the African honey bee. These achievements can be largely attributed to the promotion of innovative equipment, modern beekeeping techniques, and extension support for small-scale beekeepers.

APPEARANCE AND SIZE

Honey bees are generally easily recognized and need no description here. The

major species and subspecies are all roughly similar in appearance and size.

DISTRIBUTION

Among several hundred species of bees that store honey and pollen in harvestable amounts, only two "social" species, Apis mellifera and Apis cerana, produce multiple combs and can be kept in hives.' Given adequate forage and proper management, they can build up a honey surplus that can be harvested without harming their colonies.

Apis mellifera, the most widely distributed and exploited honey bee, comes from Europe and Africa. The subspecies from Europe (especially the Italian type, A. mellifera ligustica) is normally preferred because of its docility and high honey yields. It is now the predominant honey bee throughout the temperate zones of Europe, North America, Australasia, and China.

Of the many subspecies in Africa, A. mellifera adansonii and A. mellifera scutellata have the widest native ranges. The latter was accidently released in Brazil in 1957. It has become naturalized and has dominated the European bees formerly kept by beekeepers. By l990, it had spread northwards to the southernmost areas of the United States and southwards deep into Argentina.

The docile Asian hive bee, A. cerana, is found in Asia from the Middle East to Japan and as far south as Indonesia. Although it produces much less honey per hive than A. mellifera, its overall production in many Southeast Asian countries may be greater.

STATUS

Honey bees do not face extinction. However, genetic diversity is disappearing due to loss of habitat, insecticides, displacement by massproduced, genetically uniform queens and exotic breeds, destructive harvesting, and the spread of diseases and pests such as protozoans, bacteria, insects, and mites.

HABITAT AND ENVIRONMENT

Honey bees can exist in locations from deserts to rainforests and from near the Arctic to the tropics. They occur wherever there is nectar, pollen, tree resin (for nest building), shelter, and a little water. Heat, drought, and especially rain and humidity may curtail their activities, but a well-managed colony can survive periods of extreme adversity.

BIOLOGY

Honey bees live in rigidly hierarchical colonies. Normally there is a single queen. After mating, she begins laying hundreds of eggs a day. Those that are fertilized become sterile females, called workers; those that remain unfertilized develop into males (drones), whose only role is to fertilize future queens.

After two or three years the queen, worn-out, starts laying fewer and fewer eggs, and the colony may replace her. At that time a few female larvae are raised on royal jelly, a nutritious, little-understood secretion that causes them to develop into queens.

Workers perform different tasks as they mature. Young ones tend the queen, guard the hive, and raise the larvae. Older ones, comprising the vast majority of a colony's population, gather pollen and nectar and water. Pollen provides the

protein and fats, and the nectar, converted into honey in the bee's body, provides carbohydrates to feed the colony.

BEHAVIOR

Honey bee activities are dictated by weather, availability of food, genetics, and the overall strength of the colony. They are mediated by chemical interactions between the queen and the workers that control almost all behavior.

While the Asian and European hive bees are relatively docile, most of the African subspecies are unpredictable and may defend their colonies in great numbers and with great persistence. The threat of "killer bees" has been greatly exaggerated, however. Africans have provided them nests and hives - and harvested their honey - for thousands of years.

Occasionally, large numbers of the bees in a colony split off from their nest or hive. They usually cluster on a nearby tree or building, calmly waiting for "scouts" to find a suitable new home. These homeless swarms can be captured and will readily move into a hive- the simplest and cheapest way for beekeepers to acquire a colony.

USES

Honey and beeswax are two of nature's best known and most valuable products. Honey can be employed in hundreds of foods. It is widely used in baking because, in addition to its flavor, it retains moisture better than sugar or syrup, and the product keeps longer. Honey-based alcoholic beverages are popular in many parts of the world.

Beeswax also is used in many products, including candles, lubricants, polish, waterproofings, soaps, cosmetics, and electronics. Beeswax can be locally important for ´'lost-wax" metal-casting and sculptures as well as batik-dyed clothing.

Both bee pollen and royal jelly are used in cosmetics and can be eaten. Bee venom is used medicinally, particularly in Europe and the developing world. Bee larvae are eaten raw or fried in many parts of Asia and Africa and are considered a delicacy.

HUSBANDRY

Keeping bees means managing a colony so that it produces surplus honey or wax. Specifically this requires:

- Providing a suitable hive;

- Obtaining bees by collecting a swarm, transferring a wild colony, or purchasing a colony complete with an active queen;

- Maintaining the colony free from natural enemies in an area that allows it to produce excess honey; and

- Harvesting the excess honey without weakening the colony or causing it to flee (abscond).

ADVANTAGES

Few other livestock enterprises require less capital, less space, or less attention. Moreover, scarcely any other provides higher quality, more marketable products.

Beekeeping is a respected and traditional activity in most areas of the world. It promotes self-reliance and requires little, if any, land or money. It is an easy-entry cottage industry that can be started with minimal equipment or training. It can be done by any member of a family as it requires no special strength or size. It is especially appropriate for increasing women's income in the many areas where men are away working.

Beekeeping is suited to remote areas where many agricultural enterprises are at a competitive disadvantage because their products are bulky and far from the markets. Honey, wax, pollen, and other bee products can all be sold far from their point of origin, have high monetary value for their weight, and generally find a ready market. Local honeys often command premium prices (in part because many of them are considered medicinal). In addition, beekeeping encourages people to remain in rural areas rather than move to the city in search of an income.

Pollination increases the productivity of many crops, and therefore a few hives can boost local food production. By rotating hives among farmers' fields and orchards, a beekeeper performs a valuable service.

Beekeeping is also an important adjunct to reforestation and desert reclamation projects. It can provide income during the long wait for the trees to reach marketable size. Many forests are potential reservoirs of honey and other products. In some cases, the bees also enhance the fruitfulness and standing value of forests. They also increase pollination in tree-seed orchards and tree nurseries.

And in newly established forests, bees improve reseeding potential.

BETTER BEEHIVES

So many hives have been developed in recent years that a design now exists for almost any level of expertise. One of the most important for Third World beekeeping is the top-bar hive. This crate-like box, derived from an ancient Greek design, incorporates modern beekeeping principles but adds the innovation of sloping sides. Beneath its lid are removable boards (top bars) from which the bees hang the combs (because the sides are sloping the bees do not attach the edges of the comb to them). By lifting a top bar, the comb can be inspected and handled - and the honey harvested - with little disturbance to the colony.

This simple hive can make beekeeping accessible to even the poorest people. It is easy to build and use, and can be locally constructed from scrap lumber. It is well suited for raising most types of honey bees.

More elaborate and productive is the African long hive. In addition to having top bars, this square-sided box has removable frames within which the bees build their comb.

The most elaborate is the Langstroth hive - the type most common in temperate zones.* These yield the most honey. They can be made only where there are facilities for precise carpentry, where durable, nonwarping parts are available, and where there are good extension services to aid and assist beekeepers. Although traditional Langstroth hives are demanding to build and maintain, simplified designs have been created for use in developing countries.

STINGLESS BEES

By far the most common bees in the tropics, perhaps in the world, are bees that cannot sting. Their stingers are so akophied as to be essentially nonexistent (but some can deliver a pretty fierce bite). They live in colonies and store their honey in wax pots, some as large as egg cups.

Stingless bees can be abundant. In a two-block area in downtown Panama City, 150 nests have been counted. However, many species depend on trees and their populations are plummeting as more and more tropical forests are felled.

Like honey bees, stingless bees have been "domesticated." For thousands of years in the tropical Americas, Indians have raised them in special hives made out of logs, gourds, clay pots, and other simple containers. Cortes reported in 1519 that Indians on the island of Cozumel, the now popular tourist spot off the east coast of Yucatan, practiced beekeeping. That was almost 300 years before the European honeybee was introduced. A popular Mayan drink was honey wine, and Mayan beekeepers carved stone earplugs to keep these bees out of their ears.

Honey from stingless bees has less sugar than normal honey. However, it is usually more tasty. It is used throughout the tropics: the Americas, Central Africa, and Southeast Asia, for instance. Normally, the nests are just robbed, which devastates the bees because the queen cannot fly, and when she is disturbed the colony dies. In some areas people open a little hole in the nest. By putting in a plug, they can then harvest honey a couple of times a year without destroying the colony.

Today, a few scientists are reconsidering stingless beekeeping. In the state of Maranhao in Brazil, an area of crushing poverty, biologist Warwick Kerr is harnessing stingless bees. He began after learning that peasants were spending a third of their meager incomes buying sugar. As part of his experiments, he keeps 60 hives stacked in his garage on the outskirts of the city of San Luis. (A notable feature of these bees is that there is no prohibition against keeping them in populated areas.)

Kerr has found that stingless bees can be made to produce well. After years of experimenting with different-sized boxes, he can now obtain more than 4.5 lifers of honey per hive per year. He reports that the stingless bees are easy to maintain, and can be raised by poor peoole without land or equipment.

LIMITATIONS

Compared to raising four-footed livestock, beekeeping is inexpensive and fairly trouble free, but it is not without problems. Many things can go wrong, and include, for example:

- Losses. Bees are susceptible to various predators, pests, and diseases. Although ways to avoid or control most afflictions are available, once a colony becomes infested it may have to be destroyed.

- Theft. Hives or combs - usually kept in secluded areas - that are full of honey are tempting targets and may be stolen.

- Swarming and absconding. Some or all of the bees may leave a hive and start a new nest, taking even the honey with them.2

- Bad management. Beekeeping requires certain skills and knowledge, and sometimes frequent attention (such as when the colony is stressed, diseased, or swarming).

- Lack of equipment. Beekeepers need hives, smokers (to quiet and repel the bees), hive tools, and - advisable but not absolutely necessary - gloves and a veil.

- Inadequate storage. Some areas lack the knowledge or the bottles in which to store liquid honey.3

- Pesticides and herbicides. Nectar- and pollen-collecting bees are vulnerable to insecticides, which farmers may apply (often inappropriately) at the time their crops are flowering. Herbicides can destroy important sources of bee forage.

- Neighborhood concerns. Bees can sting people and livestock. Although wild bees (and other insects) are the principal culprits, the beekeeper is often blamed.

- Stressful conditions. When rainfall, aridity, heat, or cold are excessive, bees often cannot produce surplus honey.

RESEARCH AND CONSERVATION NEEDS

Surprisingly, much remains to be learned about the natural science of bees. Although some of the research requires sophisticated equipment and facilities, much can (or must) be performed locally by beekeepers because many factors - such as colony behavior, foraging habits, and microclimatic adaptation - depend on the local conditions. This research may include the following:

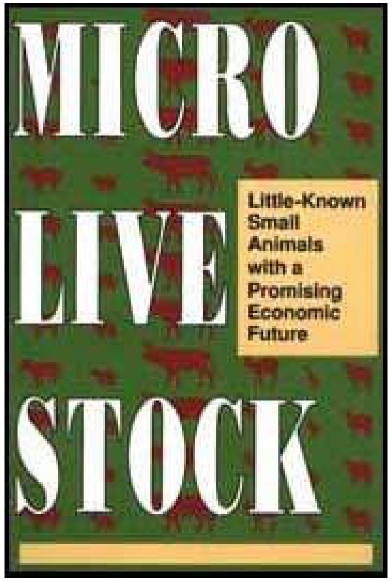
- Adaptation. The provision of locally adapted bee varieties is an important basis for developing advanced beekeeping. This can be done by selecting an appropriate local queen. Further, local breeding of queens and workers lessens the probability of importing exotic diseases and pests. Recent developments promise to move the mass production of queens and workers from the realm of high technology to common practice.4

- Integration. Continued developments in beekeeping cannot succeed without research, promotion, education, training, and extension services. These are essential for integrating beekeeping with agriculture and reforestation efforts. Thus, descriptions of agronomic plants should always include pollination requirements as well as nectar and pollen potentials. Planting nectar- and pollen-producing firewood species would increase the number of bees, which would in turn help ensure forest survival.

- Bee plants. There is still much to be understood about the relative qualities that different plants bring to beekeeping. Recently, many valuable bee-forage plants have been identified.5 These deserve special consideration in any reforestation or beautification projects. Broad introduction of these plants may also encourage beekeeping that could produce high-value "specialty" honeys or ensure more continuous production of honey. There may also be a place for "bee farms," where every plant is bee forage.

- New bee species. Nontraditional species of Apis as well as other members of the bee family (such as Anthophora, Bombus, Megachilae, Nomia, Osmia, Xylocopa, and especially Trigona and Melipona, which are stingless) should be studied to determine their role in pollination and - for some species - their further

exploitation for honey.



Micro-livestock: Little-known Small Animals with a Promising Economic Future (BOSTID, 1991, 435 p.)

Appendixes

A Selected Readings

A small selection follows of books and articles that are not too difficult to locate and that will help readers explore each topic further. Obscure documents are accompanied by an address from which readers can obtain a reprint or photocopy.

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The World's Poultry Science Journal is published 3 times a year by the World's Poultry Science Association, (c/o Institut f-r Kleintierzucht, Dornbergstrasse 25/27, Postfach 280, C-3100 Celle, Germany). It has also published a multilingual poultry dictionary.

Poultry, an international journal on poultry, is published by Misset International, a department of Uitgeversmaatschappij, C. Misset b.v., Doetinchem-The Netherlands. (Address: Misset International, P.O. Box 4, 7000 BA Doetinchem, Netherlands.)

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RABBITS

The Rabbit Research Center has been established at Oregon State University,

Corvallis, Oregon 97331, USA. It publishes the Journal of Applied Rabbit Research, whose purpose is to convey current research information to those with an interest in commercial rabbit production. The journal describes research conducted at the center and reviews rabbit research results reported in the world's scientific literature.

Founded in 1976 in Paris, the World Rabbit Science Association (Typing House, Shurdington, Cheltenhem, Gloucestershire, GL51 SXF, UK) publishes a newsletter of coming events and chronicles the progress of rabbit farming in most countries of the world. Its aims are to facilitate the advancement of the various branches of the rabbit industry, disseminate knowledge, and study problems of production and marketing. Its members represent individuals and associations in 20 countries.

The American Rabbit Breeder's Association (1925 South Main Street, Bloomington, Illinois 61701, USA) has published a book, Guide to Producing Better Rabbits, which contains an abundance of information concerning management and diseases of the domestic rabbit. The organization also publishes a bimonthly magazine, Domestic Rabbit, that includes a great deal of updated information on rabbit raising.

Asociacion Espanola de Cunicultura (Spanish Rabbit Science Association), Now, 23 08785 Ballbona d'Anoia, Barcelona, Spain, has a set of slides for training, covering breeds, handling, pathology, and commercialization.

The Report of the Workshop on Rabbit Husbandry. Copies of this report are available free of charge from the International Foundation for Science, Sibyllegatan 47, S-114 42 Stockholm, Sweden.

A Working Rabbit Literature Resources File. This materia, is directed at scientists working on some aspect of domestic rabbit research. It lists methods of computer searching for scientific reports in the world's scientific literature, various types of computer literature searches, including commerciaHy available ones, and government services. It a,so includes a list of prepared abstracts. The address is D.D. Caveny and H. L. Enos, Colorado State University, Fort Collins, Colorado 80523, USA.

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The International Bee Research Association (IBRA) publishes a Newsletter for Beekeepers in Tropical and Subtropical Countries twice each year. Its purpose is to provide a forum for exchange of information about beekeeping. The Newsletter is funded by the United Kingdom Overseas Development Agency (ODA) and is distributed free of charge to those in developing countries involved with beekeeping. Write to the International Bee Research Association, 18 North Road, Cardiff CFI 3DY, United Kingdom, for subscription information. The IBRA can also provide information on forthcoming conferences, grant programs, and the names

of other beekeepers in your country. The International Agency for Apiculture Development (IAAD) publishes a quarterly newsletter called Cornucopia that contains articles from beekeepers around the world, especially from the developing world. It provides information on producing, selling, and manufacturing hive products on a local level and discusses agroforestry and the pest and pesticide problems of honeybees. Write to Cornucopia, c/o M. Coleman, 6N 909 Roosevelt Avenue, St. Charles, Illinois 60174, USA, for a free sample. Subscriptions are $12 a year.

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B Research Contacts

This section includes the names and addresses of individuals and institutions who are familiar with the animal listed. Each person has agreed to answer requests for information and advice. This personal follow-through is the main way this book can stimulate the development of microlivestock.

MICROBREEDS

Microcattle

B.K. Ahunu, Animal Science Department, University of Ghana, P.O. Box 25, Legon, Ghana
D.O. Alonge, Meat Hygiene and Preservation Laboratory, Faculty of Veterinary

Medicine, University of Ibadan, Ibadan, Nigeria
M. Andres Poli, EEA San Luis INTA, CC 17, 5730 Mercedes (SL), Argentina
F.B. Bareeba, Department of Animal Science, Makerere University, P.O. Box 7062, Kampala, Uganda
J.A. Bennett, Department of Animal, Dairy, and Veterinary Sciences, Utah State University, Logan, Utah 84322-4815, USA
J.M. Berruecos V., School of Veterinary Medicine and Zoology, Universidad Nacional Aut6noma de MTxico, Ciudad Universitaria, Alvaro Obreg6n, 04510, Mexico D.F., Mexico
Cai Li, Animal Science and Veterinary Research Institute, Southwest College of Minority Nationalities, Chengdu, People's Republic of China
Centro de Investigaciones Pecuarias (CENIP), A.P. 227-9, Santo Domingo, Dominican Republic
G.L. Chan, B4-5 Nanyang Mansion, Shenzhen, Guangdong, People's Republic of China
Y. Cheneau, Institut d'Elevage et de MTdecine VTtTrinaire des Pays Tropicaux, Laboratoire de Farcha, BP 433, N'Djamena, Chad
Cheng Peilieu, Institute of Animal Science, Chinese Academy of Sciences, Beijing, People's Republic of China
W.R. Cockrill, 29 Downs Park West, Bristol BS6 7QH, UK
J.H. Conrad, Department of Animal Science, University of Florida, Gainesville, Florida 32611, USA
T.J. Cunha, P.O. Box R, La Verne, California 91750, USA
D.E. Deppner, Trees for the Future, 11306 Estona Drive, Silver Spring, Maryland 20902, USA (breeds of the Himalayas, East Indies)
C. Devendra, Agriculture Food and Nutrition Sciences Division, International

Development Research Centre (IDRC), Tanglin P.O. Box 101, 9124 Singapore
N.l. Dim, Department of Animal Science, Faculty of Agriculture, Institute for Agricultural Research, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria
Director, Agriculture and Forestry, PB 13184, Windhoek 9000, Namibia
V.M.S. Duarte, Instituto de Investigatao Veterinaria, C.P. 7, Huambo, Angola
M. Felius, Kerkhoflaan 47C, 3034 TA Rotterdam, The Netherlands
D. Fleharty, American Dexter Cattle Association, R.R. #1, Box 378, Concordia, Missouri 64020. USA
G. Garcia Lagombra, Animal Husbandry Department, Universidad Nacional "Pedro Henriquez Urena," Decanato Ciencias Agropecuarias, Km 5~/z Aut. Duarte, Santo Domingo, Dominican Republic
F. Gebreab, College of Veterinary Science, Addis Ababa University, Addis Ababa, Ethiopia
G.F.W. Haenlein, Department of Animal Science and Agricultural Biochemistry University of Delaware, Newark, Delaware 19717-1303, USA
Z.B. Jensen, Animal and Dairy Science Research Institute, PB X02, Irene, Transvaal 1675, South Africa
Jin Xizhen, Animal Science and Veterinary Research Institute, Southwest College of Minority Nationalities, Chengdu, People's Republic of China
G. Kitsopanidis, Faculty of Agriculture, Aristotelian University of Thessaloniki, University Campus, Thessaloniki, Greece
G.E. Kodituwakku, Department of Veterinary Clinical Studies, University of Peradeniya, Peradeniya, Sri Lanka
N.M. Konnerup, 74 North Sunrise Boulevard, Camano Island, Washington 98292, USA
L.Y.L. Li, Department of Animal Husbandry and Veterinary Science, South China

Agricultural College, Ghangzhou, People's Republic of China
J.K. Loosli, 406 S.W. 40th Street, Gainesville, Florida 32607, USA
A.B. Lwoga, Sokoine University of Agriculture, P.O. Box 3000, Morogoro, Tanzania
A. Martinez Balboa, Legaspy 1025, Apartado Postal 43, 23000, La Paz, Baja California Sur, Mexico
A. Masam, Livestock Training Institute, Tengeru, P.O. Box 3101, Arusha, Tanzania
J.P. Maule, Hannahfield Quarry House, 578 Lanark Road West, Balerno, Midlothian EH 14 7BN, UK
M. Mazid, Faculty of Agriculture, University of Aleppo, Aleppo, Syria
L.R. McDowell, Department of Animal Sciences, University of Florida, Gainesville, Florida 32611, USA
J.A. Morgan, College of Natural Resources and Environmental Studies, University of Juba, P.O. Box 82, Juba, Sudan
D.B. Mpiri, Livestock Production Research Institute, Private Bag, Mpwapwa, Tanzania
Ni Shicheng, Animal Husbandry and Veterinary Science, Zhejiang Agricultural University, Hangzhou, People's Republic of China
B. Nikolov, Institute of Cattle and Sheep Breeding, 6000 Stara Zagora, Bulgaria
T. Olson, University of Florida, Gainesville, Florida 32611, USA
T.W. Perry, Department of Animal Sciences, Purdue University, West Lafayette, Indiana 47907, USA
R.W. Phillips, The Representative, Apartment 810, 1101 South Arlington Ridge Road, Arlington, Virginia 22202, USA
F. Pirchner, Technical University of Munich, D-8050 Munich-Weihenstephan, Germany
A. Ramamohana Rao, Postgraduate Studies, Andhra Pradesh Agricultural

University, Rajendranagar, Hyderabad, Andhra Pradesh 500 030, India
Soedomo Reksohadiprodjo, Department of Animai Nutrition, Faculty of Animal Husbandry, Universitas Gadjah Mada, Sekip Blok N-42, Yogyakarta, Indonesia
A.Y. Robles, Dairy Training and Research Institute, University of the Philippines at Los Banos, College, Laguna 3732, Philippines
Sie Cheuxia, Department of Animal Science, Nanjing Agricultural University, Nanjing, People's Republic of China
A.D. Tillman, 523 West Harned Place, Stillwater, Oklahoma 74074, USA
J.C.M. Trail, Livestock Productivity and Trypanotolerance Group, International Livestock Centre for Africa (ILCA), P.O. Box 30709, Nairobi, Kenya
A.C. Warnick, Department of Animal Science, University of Florida, Gainesville, Florida 32611, USA

Microgoat

E.A. Adebowale, Institute of Agricultural Research and Training, University of Ife, Moor Plantation, P.M.B. 5029, Ibadan, Nigeria
A.A. Adeloye, Faculty of Agriculture, Adeyemi College of Education, Onjo, Nigeria
A.A. Ademosun, Department of Animal Science, University of Ife, lle-Ife, Nigeria
I.F. Adu, N.A.P.R.I., Ahmadu Bello University, Zaria, Nigeria
I.A. Akinbode, Faculty of Agriculture, University of Ife, Ile-Ife, Nigeria
A.O. Akinsoyinu, Department of Animal Science, University of Ibadan, Ibadan, Nigeria
J.A. Akonji, Institut de Recherches Zootechniques, Office National de la Recherche Scientifique et Technique (ONAREST), B.P. 65, Yaounde, Cameroon
D.O. Alonge, Faculty of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria
Baik Dong Hoon, Department of Animal Science, College of Agriculture, Jeonbug

National University, JEONJU, 520, Republic of Korea
J.S.F. Barker, Department of Animal Science, University of New England, Armidale, New South Wales 2351, Australia
K. Boateng, Cooperative Extension Service, University of the Virgin Islands, Box L, Kingshill, St. Croix, Virgin Islands 00850, USA
G.E. Bradford, University of California, Davis, California 95616, USA
M.S. Browne, Nutrition Consulting Services, P.O. Box 788, St. Thomas, Virgin Islands 00801, USA
T.D. Bunch, Department of Animal, Dairy, and Veterinary Sciences, Utah State University, Logan, Utah 84322-4815, USA
T.C. Cartwright, Department of Animal Science, Texas A&M University, College Station, Texas 77843, USA
Centro de Investigaciones Pecuarias (CENIP), A.P. 227-9, Santo Domingo, Dominican Republic
C. Devendra, Agriculture Food and Nutrition Sciences Division, International Development Research Centre (IDRC), Tanglin P.O. Box 101, 9124 Singapore, Singapore
N.I. Dim, Department of Animal Science, Faculty of Agriculture, Institute for Agricultural Research, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria
D. Fielding, Centre for Tropical Veterinary Medicine, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush, Roslin, Midlothian EH25 9RG, Scotland, UK
H.A. Fitzhugh, Winrock International, Route 3, Petit Jean Mountain, Morrilton, Arkansas 72110, USA
W.C. Foote, Utah State University International Sheep and Goat Institute, UNC 48, Utah State University, Logan, Utah 84322, USA

G.R. Gerona, Department of Animal Science and Veterinary Medicine, Visayas State College of Agriculture, Baybay, Leyte, Philippines
G.F.W. Haenlein, Department of Animal Science and Agricultural Biochemistry, University of Delaware, Newark, Delaware 19717-1303, USA
A. Essa Haid, Essa International, Inc., 2550 M Street, Suite 405, Washington, D.C. 20037, USA (small East African)
W. Harding, Agrarian Society, Palazzo de la Salle, Valletta, Malta
M.A. Hasnath, Department of Animal Husbandry, Bangladesh Agricultural University, P.O. Agricultural University, Mymensingh, Bangladesh
A.S. Hoversland, Division of Research Grants, National Institutes of Health, 5333 Westbard Avenue, Bethesda, Maryland 20205, USA
L. Hulse, National Pygmy Goat Association, RFD #1, Fern Avenue, Amesbury, Massachusetts 01913, USA
T.P. Husband, Department of Natural Resource Science, University of Rhode Island, Kingston, Rhode Island 02881, USA (bezoar, agrimi)
D.L. Huss, P.O. Box 426, Menard, Texas 76859, USA
B. Hutchins, 2535 Halsted Road, Apartment 1, Rockford, Illinois 61103, USA
N. Iba+ez Herrera, Paraguay 160-Urbanizacion, Apartado 315, El Recreo, Trujillo, Peru
S. Karam Shah, Livestock Experimental Station Rakh Khairewala, District Muzaffergarh, Pakistan
C. Katongole, Faculty of Veterinary Medicine, Makerere University, PO Box 7062, Kampala, Uganda
G. Kiwuwa, Department of Animal Science, Makerere University, PO Box 7062, Kampala, Uganda
L.Y.L. Li, Department of Animal Husbandry and Veterinary Science, South China

Agricultural College, Ghangzhou, People's Republic of China
D.R. Lincicome, Animal Parasitology Institute, U.S. Department of Agric£lture, Building 1180, BARC-East, Beltsville, Maryland 20705, USA
Liu Chengxiang, Animal Husbandry and Veterinary Science Research Institute, Guang^ dong Agricultural Academy, Guangdong, People's Republic of China
J.K. Loosli, 406 S.W. 40th Street, Gainesville, Florida 32607, USA
M. Mahyuddin Dahan, Department of Animal Sciences, Universiti Pertanian Malaysia, Serdang, Selangor, Malaysia
G.C.H. Mandari, Livestock Research Centre, West Kilimanjaro, P.O. Box 103, Hai, Tanzania
J. Mann, Institute of Tropical Veterinary Medicine, University of Giessen, Germany
A. Martinez Balboa, Legaspy 1025, Apartado Postal 43, 23000, La Paz, Baja California Sur, Mexico
I. Mecha, Department of Animal Science, University of Nigeria, Nsukka, Anambra State, Nigeria
J. Metcalf, School of Medicine, University of Oregon, Eugene, Oregon 97403, USA
K. Mitchell, Baptist Bible Institute, P.O. Box 301, Basseterre, St. Kitts, West Indies
M. Khusahry Mohd Yusuff, Malaysian Agricultural and Research Institute (MARDI), G.P.O. Box 12301, Kuala Lumpur 01-02, Malaysia
A. Monsi, Departments of Animal Science/Food Science and Technology, Rivers State University of Science and Technology, P.M.B. 5080, Port Harcourt, Nigeria
G. Montsma, Klomperweg 79, 6741 PD, Lunteren, Netherlands
J. Moore, Department of Animal Science, University of Florida, Gainesville, Florida 32611, USA
C.M. Munyabuntu, Department of Animal Science, P.O. Box 7062, Makerere University' Kampala, Uganda

Th. Murayi, Institut des Sciences Agronomiques du Rwanda, P.O. Box 138, Butare, Rwanda

W.N.M. Mwenya, School of Agricultural Sciences, University of Zambia, Box 32379, Lusaka, Zambia

A. Nivyobizi, FacultT des Sciences Agronomiques, UniversitT du Burundi, BP 2940, Bujumbura, Burundi

G.A. Norman, Tropical Development Research Institute, 56/62 Gray's Inn Road, London WCIX 8LU, UK

K. Okello-Lapenga, Department of Veterinary Pathobiology, Makerere University, PO Box 7062, Kampala, Uganda

S. Ramahefarison, DTpartement de Recherches Zootechniques et VTtTrinaires tCENRADERU), BP 904, Amatobe, Antananarivo, Madagascar

A. Ramamohana Rao, Postgraduate Studies, Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad, Andhra Pradesh 500 030, India

R.K. Rastogi, Department of Livestock Science, University of the West Indies, St. Augustine, Trinidad, West Indies

G. Rasul, District Forest Officer & Wildlffe Warden, P.O. Box 501, Gilgit (northern area), Pakistan

D. Rattner, Institute of Animal Research, Kibbutz Lahav, Israel (Sinai goat, ya-ez hybrids)

Soedomo Reksohadiprodjo, Department of Animal Nutrition, Faculty of Animal Husbandry, Universitas Gadjah Mada, Sekip Blok N-42, Yogyakarta, Indonesia

A. Repollo, Jr., Palawan National Agricultural College, Aborlan, Palawan, Philippines

A.Y. Robles, Dairy Training and Research Institute, University of the Pbilippines, Los Banos, Laguna 3732, Philippines

A. Rocha, Instituto de Reprodutao e Melhoramento Animal, C.P. 25, Matola, Mozambique
C. Rodriguez, Centro de Investigaciones Pecuarias (CENIP), Autopista Duarte Km 24, Apartado 227-9, Santo Domingo, Dominican Republic
M. Nasim Siddiqi, Zoology Department, University of Peshawar, N.W.F.P., Pakistan
M. Shelton, Texas A & M University, College Station, Texas 77843, USA (criollo)
A. Shkolnik, Department of Zoology, Tel Aviv University, Tel Aviv, Israel
O.C. Simpson, Cameroon Road, Prairie View A&M University, Prairie View, Texas 77445, USA
Sie Chenxia, Department of Animal Science, Nanjing Agricultural University, Nanjing, People's Republic of Cbina
R.G. Wahome, Department of Animal Production, University of Nairobi, P.O. Box 29053, Nairobi, Kenya
R. Watts, Animal Science Department, Natural Resources Development College, Lusaka, Zambia
R.T. Wilson, Bartridge House, Umberleigh, North Devon EX37 9AS, UK
H. Wood, Highland Game Farm, Route 4, Box 450, Alexandria, Indiana 46001, USA
T.P. Husband, Department of Natural Resources Science, University of Rhode Island, Kingston, Rhode Island 02881, USA

Microsheep

E.A. Adebowale, Institute of Agricultural Research and Training, University of Ife, Moor Plantation, P.M.B. 5029, Ibadan, Nigeria
I.F. Adu, N.A.P.R.I., Ahmadu Bello University, Zaria, Nigeria
I.A. Akinbode, Faculty of Agriculture, University of Ife, Ile-Ife, Nigeria
A.O. Akinsoyinu, Department of Animal Science, University of Ibadan, Ibadan,

Nigeria

M. Amin, Jammu and Kashmis State Sheep and Shearing Products Development Board, Nowshera, Srinigar, Kashmir 190 011, India

Ahmad Mustaffa B. HJ. Babjee, Veterinary Services Department, Ibu Pejabat Perkhidmatan Haiwan, Kementerian Pertanian, Malaysia, Jalan Mahameru, Kuala Lumpur 10-02, Malaysia (grazing in rubber plantations)

J.S.F. Barker, Department of Animal Science, University of New England, Armidale, New South Wales, 2351, Australia (Indonesian breeds)

K. Boateng, Cooperative Extension Service, College of the Virgin Islands, Box L, Kingshill, St. Croix, Virgin Islands 00850, USA

G.E. Bradford, University of Calffornia, Davis, Calffornia 95616, USA

R. Breckle, U.S. Forest Service, Alsea, Oregon 97324, USA (grazing sheep in forests)

T. Bunch, Department of Animal, Dairy, and Veterinary Sciences, Utah State University, Logan, Utah 84322-4815, USA (Iranian thin-tailed, Navajo, wild-sheep hybrids)

M. Carpio P., Departamento de Produccion Animal, Universidad Nacional Agraria, Apartado 456, La Molina, Lima, Peru

Centro de Investigaciones Pecuarias (CENIP), A.P. 227-9, Santo Domingo, Dominican Republic

S. Cottrell, Pippin Farm, 3081 Goshen Road, Bellingham, Washington 98226, USA

C. Courtney, Veterinary Faculty, University of Florida, Gainesville, Florida 32611, USA

D. Deller, Virgin Islands Department of Agriculture, St. Thomas, Virgin Islands 00820, USA

A. Dettmers, 5620 Longwood Avenue, Port Charlotte, Florida 33953, USA (West

African dwarf)
C. Devendra, Agricultural Food and Nutrition Sciences Division International Development Research Centre (IDRC), Tanglin P.O. Box 101, 9124 Singapore, Singapore
N.l. Dim, Department of Animal Science, Faculty of Agriculture, Institute for Agricultural Research, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria
K. Drew, Invermay Agricultural Research Centre, Private Bag, Mosgiel, New Zealand
F. El Amin, Department of Animal Husandry, Faculty of Veterinary Science, University of Khartoum, P.O. Box 32, Khartoum North, Sudan
Gholam-Hossein Erabi, Faculty of Agriculture, University of Tabriz, Tabriz 51664, Iran
H.A. Fitzhugh, Winrock International Institute for Agricultural Development, Route 3, Petit Jean Mountain, Morrilton, Arkansas 72110, USA
W. Foote, Animal' Dairy, and Veterinary Science Department, UNC 48, Utah State University, Logan, Utah 84322-4815, USA (Virgin Islands white hair, wild-sheep hybrids)
E.-H. Gueye, Centre de Recherches Zootechniques de Kolda, Institut SenTgalais de Recherches Agricoles, (ISRA), B.P. 53, Kolda, Senegal
G. Garcia Lagombra, Animal Husbandry Department, Universidad Nacional "Pedro Henriquez Urena," Decanato Ciencias Agropecuarias, Km 5 1/2 Aut. Duarte, Santo Domingo, Dominican Republic
G.F.W. Haenlein, Department of Animal Science and Agricultural Biochemistry, University of Delaware, Newark, Delaware 19717-1303, USA
E. Henson, Bemborough, Guiting Power, Cheltenham, Gloucester, UK (rare breeds)
D.L. Huss, P.O. Box 426, Menard, Texas 76859, USA

N. Ibanez Herrera, Paraguay 160 - Urbanizacion, Apartado 315, El Recreo, Trujillo, Peru
P. Jewell, Department of Physiology, University of Cambridge, Cambridge CB2 ITN, UK
Jones Sheep Farm, RR 2 Box 185-55, Peabody, Kansas 66866, USA
P.E. Loggins, Animal Science Department, 108-D Suite, University of Florida, Gainesville, Florida32611, USA
J.K. Loosli, 406 S.W. 40th Street, Gainesville, Florida 32607, USA
G.C.H. Mandari, Livestock Research Centre, West Kilimanjaro, P.O. Box 103, Hai, Tanzania
J.P. Maule, Hannahfield Quarry House, 578 Lanark Road West, Balerno, Midlothian EH14 7BN, UK
L.K. McNeal, Animal, Dairy, and Veterinary Science Department, UNC 48, Utah State University, Logan, Utah 84322-4815, USA
I. Mecha, Department of Animal Science, University of Nigeria, Nsukka, Anambra State, Nigeria
K. Mitchell, Baptist Bible Institute, P.O. Box 301, Basseterre, St. Kitts, West Indies
A. Monsi, Department of Animal Science, Food Science and Technology, Rivers State University of Science and Technology, P.M.B. 5080, Port Harcourt, Nigeria
C.M. Munyabuntu, Department of Animal Science, Makerere University, P.O. Box 7062, Kampala, Uganda
Th. Murayi, Institut des Sciences Agronomiques du Rwanda, P.O. Box 138, Butare, Rwanda
W.N.M. Mwenya, School of Agriculture Sciences, University of Zambia, Box 32379, Lusaka, Zambia
M. Ngendahayo, Institut des Sciences Agronomiques du Rwanda, B.P. 138, Butare,

Rwanda
R. Njwe, DTpartement des Sciences Animales, Ecole Nationale SupTrieure Agronomique, Centre Universitaire de Dschang, B.P. 138, YaoundT, United Republic of Cameroon
W.J.A. Payne, 91 Bedwardine Road, London SE19 3AY, UK
R.W. Phillips, The Representative, Apartment 810, 1101 South Arlington Ridge Road, Arlington, Virginia 22202, USA
G.V. Raghavan, Animal Science Department, College of Veterinary Science, Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad 500 030, Andhra Pradesh, India
A. Ramamohana Rao, Postgraduate Studies, Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad, Andhra Pradesh 500 030, India
R.K. Rastogi, Department of Livestock Science, University of the West Indies, St. Augustine, Trinidad, West Indies
Soedomo Reksohadiprodjo, Department of Animal Nutrition, Faculty of Animal Husbandry, Universitas Gadjah Mada, Sekip Blok N-42, Yogyakarta, Indonesia
A.Y. Robles, Dairy Training and Research Institute, University of the Philippines at Los Banos, College, Laguna 3732, Philippines
A. Rocha, Instituto de Reprodutao e Melhoramento Animal, C.P. 25, Matola, Mozambique
M.L. Ryder, c/o H.F.R.O., Bush Estate, Penicuik, Edinburgh, UK (Barbados blackbelly, wool)
Sie Chenxia, Department of Animal Science, Nanjing Agricultural University, Nanjing, People's Republic of China
C. David Simpson, Range and Wildlife Department, Texas Tech University, P.O. Box 4349, Lubbock, Texas 79409, USA

C.E. Terrill, U.S. Department of Agriculture, Building 005, BARC-West, Beltsville, Maryland 20705, USA
H.N. Turner, Genetics Research Laboratories, CSIRO, P.O. Box 184, North Ryde, New South Wales 2113, Australia (Indonesian breeds)
R. Vaccaro, Universidad Nacional Agraria, La Molina, P.O. Box 456, Lima, Peru
R.G. Wahome, Department of Animal Production, P.O. Box 29053, Nairobi, Kenya
S. Wildeus, College of the Virgin Islands, Agricultural Experiment Station, R.R. 2, Box 10051 Kingshill, St. Croix, Virgin Islands 00850, USA
R.T. Wilson, Bartridge House, Umberleigh, North Devon EX37 9AS, UK
Wu Jitang, Animal and Veterinary Science, Jiangsu Province Academy of Agricultural Sciences, Nanjing, People's Republic of China
A. Yenikoye, FacultT d'Agronomie, UniversitT de Niamey, B.P. 10662, Niamey, Niger

Micropig

I.A. Akinbode, Faculty of Agriculture, University of Ife, Ile-Ife, Nigeria
D.O. Alonge, Meat Hygiene and Preservation Laboratory, Faculty of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria
J.M. Andrews, Mesoamerican Ecology Institute, Tulane University, New Orleans, Louisiana 70118, USA (Yucatan pig)
G. Ashton-Peach, Box 17, Ohaeawai, Bay of Islands, New Zealand (kunekune)
M. Berruecos V. Muz, Facultad de Medicina Veterinaria y Zootecnia, Ciudad Universitaria, Mexico D.F., Mexico
R. Blakely, Sedgwick County Zoo, Wichita, Kansas 67203, USA (Ossabaw)
K. Boateng, Cooperative Extension Service, University of the Virgin Islands, Box L., Kingshill, St. Croix, Virgin Islands 00850, USA

I.L. Brisbin, Savannah River Ecology Laboratory, P.O. Drawer E, Aiken, South Carolina 29801, USA (Ossabaw)

L. Bustad, Veterinary School, Washington State University, Pullman, Washington, 99163, USA

C. Catibog-Sinha, Forest Products Research and Development Institute, College, Laguna 4031, Philippines

Centro de Investigaciones Pecuarias (CENIP), A.P. 227-9, Santo Domingo, Dominican Republic

Charles River Laboratories, Inc., 251 Ballardvale Street, Wilmington, Massachusetts 01887-0630, USA

J.H. Conrad, Department of Animal Science, University of Florida, Gainesville, Florida 32611, USA

T.J. Cunha, PO Box R, LaVerne, California 91750, USA

F. Dederer, 712 Brown Street, Philadelphia, Pennsylvania 19123, USA

A. Dettmers, 5620 Longwood Avenue, Port Charlotte, Florida 33953, USA (miniature pigs)

C. Devendra, Agriculture Food and Nutrition Sciences Division, International Development Research Centre (IDRC), Tanglin P.O. Box 101, 9124 Singapore

N.I. Dim, Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria

G. Edgar, Greenhill, I R.D., Balfour, Southland, New Zealand (kunekune)

H. Hendricks, Department of Animal, Dairy, and Veterinary Sciences, Utah State University, Logan, Utah 84322-4815, USA

B.J. Hepburn, Swine Program, Charles River Laboratories, 251 Ballardvale Street, Wilmington, Massachusetts 01887-0630, USA (laboratory pigs)

P. Holbrook, Aria Road' via Te Kuiti, New Zealand (kunekune)

R.R. Hook, Jr., Sinclair Medical Research Farm, University of Missouri, Route 3, Columbia, Missouri 65203, USA (laboratory pigs)

J.O. Ilori, Faculty of Agriculture, University of If e, Ile-Ife, Nigeria

G. E. Kodituwakku, Department of Veterinary Clinical Studies, University of Peradeniya, Peradeniya, Sri Lanka

J.K. Loosli, 406 S.W. 40th Street' Gainesville, Florida 32607, USA

J.H. Maner, Winrock International, Route 3, Petit Jean Mountain, Morrilton, Arkansas 72110, USA

J.J. Mayer, Savannah River Ecology Laboratory, P.O. Drawer E, Aiken, South Carolina 29801, USA (Ossabaw)

K. Mitchell, Baptist Bible Institute, P.O. Box 301, Basseterre, St. Kitts, West Indies

A. Monsi, Departments of Animal Science/Food Science and Technology, Rivers State University of Science and Technology, P.M.B. 508O, Port Harcourt, Nigeria

J. Mtimuni, Livestock Production Department, Bunda College of Agriculture, University of Malawi, P.O. Box 219, Lilongwe, Malawi

D.G. Mugisa, c/o Insure Consult, P.O. Box 30002, Nakivubo, Kampala, Uganda

K. Mull, 2834 Hamner Avenue #208, Norco, California 91760, USA

W.L.R. Oliver, Pigs and Peccaries Specialist Group, Jersey Wildlife Prescrvation Trust, Les AugrFs Manor, Jersey, Channel Islands, UK (pigmy hog)

L. Panepinto, Redstone Canyon, P.O. Box 105, Masonville, Colorado 80541, USA (miniature pigs)

W.J.A. Payne, 91 Bedwardine Road, London SE19 3AY, UK

C.C. Perdomo, Centro Nacional de Pesquisa de Suinos e Aves, BR 153, km 110, CP D-3, 89700 Concordia, SC, Brazil

R.W. Phillips, The Representative, Apartment 810, 1101 South Arlington Ridge Road, Arlington, Virginia 22202, USA (Chinese breeds)

W.G. Pond, Meat Animal Research Center, U.S. Department of Agriculture, Box 166, Clay Center, Nebraska 68933, USA
H. Popenoe, International Programs in Agriculture, 3028 McCarty Hall, University of Florida, Gainesville, Florida 32611, USA (New Guinea pigs)
B.S. Reddi, CoHege of Veterinary Science, Andhra Pradesh Agricultural University, Tirupati 517 502, India
S. Avendano Reyes, Instituto Nacional de las Investigaciones sobre los Recursos BiotTcnicos, (INIREB), Apartado Postal 97, MTrida, Yucatan, Mexico (Yucatan)
C. Robinson, Robinson's Racing Pigs, 5809 20th Avenue South, Tampa, Florida 336195457, USA (miniature pigs)
C. Arellano Sota, Regional Office for Latin America and the Caribbean, Food and Agriculture Organization of the United Nations, Casillo 10095, Santiago, Chile (Cuing)
A. Sriramamurty, College of Veterinary Science, Andhra Pradesh Agricultural University, Tirupati 517 502, India
M.M. Swindle, Comparative Medicine/Lab Animal Resources, Medical University of South Carolina, 171 Ashley Avenue, Charleston, South Carolina 29425, USA (laboratory pigs)
N. Tilakaratne, Veterinary Research Institute, Gannoruwa, Peradeniya, Sri Lanka
R.G. Wahome, Department of Animal Production, P.O. Box 29053, Nairobi, Kenya
Wu Jitang, Animal and Veterinary Science, Jiangsu Provincial Academy of Agricultural Sciences, Nanjing, People's Republic of China
Yong Shen Lee, Department of Animal Husbandry and Veterinary Medicine, South China Agricultural University, Guangzhou, People's Republic of China

POULTRY

Information on poultry can generally be obtained from local ministries of agriculture or veterinary and livestock services. However, another source is the World's Poultry Science Association (c/o Institut fur Kleintierzucht, Dornbergstrasse 25/27, Postfach 280, C-3100 Celle, Germany). It has over 5,000 members from 40 national groups. Its objectives are (1) to advance poultry science and the poultry industry, (2) to disseminate and facilitate the exchange of knowledge pertaining to all branches of the poultry industry, (3) to encourage the promotion of world poultry congresses and regional conferences, and (4) to cooperate with other international organizations. It maintains working groups to explore and assess research work on tropical poultry problems. The World's Poultry Science Journal is published 3 times a year. It has also published a multilingual poultry dictionary.

Chicken

A.O. Aduku, Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria
D.O. Alonge, Meat Hygiene and Preservation Laboratory, Faculty of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria
A. Ben-David, Poultry Production Specialist, 5, Azar Street, Holon 58291, Israel
I.L. Brisbin, Jr., Savannah River Ecology Laboratory, P.O. Drawer E, Aiken, South Carolina 29801, USA
J.K. Camoens, Senior Livestock Specialist, Asian Development Bank, P.O. Box 789, Manila 2800, Philippines
J.R. Couch, Poultry Science Department, Texas A&M University, College Station, Texas 77843, USA
R.D. Crawford, Department of Animal and Poultry Science, University of

Saskatchewan, Saskatoon, Saskatchewan S7N 0W0, Canada
M. Cuca G., Institucion de Ensenanza e Investigacion en Ciencias Agricolas, Colegio de Postgraduados, Chapingo, Mexico
N.I. Dim, Animal Science Department, Faculty of Agriculture, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria
D. Fielding, Centre for Tropical Veterinary Medicine, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush, Roslin, Midlothian EH25 9RG, Scotland, UK
R.O. Hawes, Department of Animal and Veterinary Sciences, University of Maine, Orono, Maine 04469, USA
D. Holderread, P.O. Box 492, Corvallis, Oregon 97339, USA
C.H. Huang, Food and Fertilizer Technology Center for the Asian and Pacific Region, Fifih Floor, 14 Wenchow Street, Taipei, Taiwan
E.H. Ketelaars, Department of Tropical Husbandry, P.O. Box 338, 6700 A.H. Wageningen, The Netherlands
M.A. Latif, Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, Bangladesh
H. Martoyo, Faculty of Animal Science, Institut Pertanian Bogor, Jalan Raya Pajajaran, Bogor, West Java, Indonesia
K. Mitchell, Baptist Bible Institute, P.O. Box 301, Basseterre, St. Kitts, West Indies
E.T. Moran, Jr., Poultry Science Department, Auburn University, Auburn, Alabama 36849-4291, USA
S. Ochetim, School of Agriculture, University of the South Pacific, Alafua Campus, Apia, Western Samo
S. Parks, Route 1, Box 47-C, Brookshire, Texas 77423, USA (Araucanian chicken)
R.W. Phillips, The Representative, Apt.810, 1101 South Arlington Ridge Road,

Arlington, Virginia 22202, USA
H.L. Polley, Programme DTveloppement Plateau Bateke, CBZO, B.P. 4728, Kinshasa 2, Zaire
A. Ramakrishman, Center for Advanced Studies in Poultry Science, Kerala Agricultural University, Mannuthy 680 651, Kerala, India
C.V. Reddy, Faculty of Veterinary Science, Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad 500 030, India
E. Ross, Department of Animal Science, University of Hawaii, Honolulu, Hawaii 96822, USA
M.L. Scott, 16 Spruce Lane, Ithaca, New York 14850, USA
T.J. Sexton, Agricultural Research Service, U.S. Department of Agriculture, Beltsville Agricultural Research Center, Building 262, Beltsville, Maryland 20705, USA
R.G. Somes, Nutritional Sciences, Box U-17, University of Connecticut, Storrs, Connecticut 06268, USA
M. Sunde, Poultry Science Department, University of Wisconsin, Madison, Wisconsin 53706, USA
R.T. Wilson, Bartridge House, Umberleigh, North Devon EX37 9AS, UK

Duck

R.E. Abdelsamie, Department of Biochemistry, Microbiology, and Nutrition, University of New England, Armidale, New South Wales 2351, Australia
S. Ahmed, Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, Bangladesh
A. Bande, PATI, Popondetta Agricultural College, Box 131, Popondetta, Oro Province, Papua New Guinea

R.S. Bird, Cherry Valley Farms Ltd., Rothwell, Lincoln LN7 6BR, UK
V.D. Bulbule, Central Duck Breeding Farm, Government of India, Hessaraghatta, Bangalore 560 088, India
J.K. Camoens, Asian Development Bank, P.O. Box 789, Manila 2800, Philippines
K.M. Cheng, Avian Genetics Laboratory, Department of Animal Science, University of British Columbia, Vancouver, British Columbia V6T 2A2, Canada
W.F. Dean, Cornell University Duck Research Laboratory, P.O. Box 217, Eastport, New York 11941, USA
N.I. Dim, Animal Science Department, Faculty of Agriculture, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria
P. Edwards, Agricultural and Food Engineering Division, Asian Institute of Technology, P.O. Box 2754, Bangkok 10501, Thailand
L. Fishelson, Department of Zoology, Tel Aviv University, Ramat-ave, Tel Aviv 69978, Israel
W.F. Floresca, Department of Animal Science and Veterinary Medicine, Visayas State College of Agriculture, Baybay, Leyte 7127, Philippines
H. Godoy, Ingeniero Agronomio, Simon Bolivar 2397, Santiago, Chile
P. Hardjosworo, Fakultas Peternakan, Institut Pertanian Bogor, Bogor, Indonesia
R. Henry, Cherry Valley Farms Limited, Divisional Offices, North Kelsey Moor, Lincoln LN7 6HH, UK
D. Holderread, P.O. Box 492, Corvallis, Oregon 97339, USA
W.F. Hollander, Route 4, Box 168, Ames, lowa 5001O, USA
E. Hoffmann, Canning, Nova Scotia BOP IHO, Canada
C.H. Huang, Food and Fertilizer Technology Center for the Asian and Pacific Region, Fifth Floor, 14 Wenchow Street, Taipei, Taiwan
G. Ibanez H., Bolivar 451, Trujillo, Peru

Z. Jungkaro, Research Institute for Inland Fisheries, Jalan Sempur No. 1, Indonesia

G.A.R. Kamar, Animal Production Department, Faculty of Agriculture, Cairo University, Giza, Egypt

E.H. Ketelaars, Department of Tropical Husbandry, P.O. Box 338, 6700 A.H. Wageningen, The Netherlands

I.P. Kompiang, BaliPenelitianTernak, P.O. Box 123, Bogor 16001, WestJava, Indonesia

M.A. Latif, Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, Bangladesh

H. Martoyo, Faculty of Animal Science, Institut Pertanian Bogor, Jalan Raya Pajajaran, Bogor, Indonesia

P. Mongin, Station de Recherches Avicoles, I.N.R.A., Nouzilly 37380 Monnaie, France

E.T. Moran, Jr., Poultry Science Department, Auburn University, Auburn, Alabama 36849-4291, USA

S. Ochetim, School of Agriculture, University of the South Pacific, Alafua Campus, Apia, Western Samoa

R.W. Phillips, The Representative, Apartment 810, 1101 South Arlington Ridge Road, Arlington, Virginia 22202, USA

H. Pingel, Karl-Marx-Universitat, Sektion TV, Lehrstuhl Geflugel- und Pelztierzucht, 7010 Leipzig, Stephanstrasse 12, Germany

S. Poernomo, Research Institute for Veterinary Science, Jalan R.E. Martadinata 32, P.O. Box 52, Bogor, West Java, Indonesia

A. Ramakrishman, Center for Advanced Studies in Poultry Science' Kerala Agricultural University, Mannuthy 680 651, Kerala, India

B. Retailleau, Grimaud FrFres S.A., La CorbiFre, 49450 Roussay, France
T.S. Sandhu, Cornell University Duck Research Laboratory, P.O. Box 217, Eastport, New York 11941, USA
M.L. Scott, 16 Spruce Lane, Ithaca, New York 14850, USA
B.K. Shingari, Department of Animal Science, Punjab Agricultural University, Ludhiana 141 004, India
C. Tai, Taiwan Livestock Research Institute, 112 Farm Road Shin-hua, Tainan, Taiwan 71210
B. Tangendjaja, Bali Penelitian Ternak, P.O. Box 123, Bogor 16001, Indonesia
Tian Fuh Shen, Department of Animal Husbandry, National Taiwan University, Taipei 10764, Taiwan
S.S. Tsai, Laboratory of Veterinary Pathology, National Pintung Institute of Agriculture, Pintung, Taiwan
A. Romero Villanueva, Centro Tropical de Capacitaci6n Agropecuaria y Forestal, Apartado Postal #4S, Macuspana 86700 Tabasco, Mexico
R.T. Wilson, Bartridge House, Umberleigh, North Devon EX37 9AS, UK
Wildfowl Trust, Slimbridge, UK
Yeong Shue Woh, Malaysian Agricultural Research and Development Institute (MARDI), G.P.O. No. 12301, 50774 Kuala Lumpur, Malaysia
Cha Tak Yimp, Poultry and Swine Unit, Department of Veterinary Services, Jalan Mahameru, 50630 Kuala Lumpur, Malaysia

Geese

Many universities have a department of animal or poultry science that should know about the culture and management of these birds.

A. Bande, PATI, Popondetta Agricultural College, Box 131, Popondetta, Oro Province, Papua New Guinea
J.K. Camoens, Asian Development Bank, P.O. Box 789, Manila 2800, Philippines
F.D. Chesterley, 4502 Loomis Trail, Blaine, Washington 98230, USA
R.D. Crawford, Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W0, Canada
N.l. Dim, Animal Science Department, Faculty of Agriculture, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria
D. Holderread, P.O. Box 492, Corvallis, Oregon 97339, USA
S. Jackson, P.O. Box 3, Creenbank, Washington 98253, USA (weeder geese)
Liu Fuan, Department of Animal Husbandry and Veterinary Medicine, South China Agricultural University, Guangzhou, People's Republic of China
P. Mongin, Station de Recherches Avicoles, l.N.R.A., Nouzilly 37380, Monnaie, France
E. Ross, Department of Animal Science, University of Hawaii, Honolulu, Hawaii 96822, USA
B.K. Shingari, Department of Animal Science, Punjab Agricultural University, Ludhiana 141 004, India
H.R. Wilson, Poultry Science Department, University of Florida, Gainesville, Florida 32611, USA

Guinea Fowl

A.O. Aduku, Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria
American Guinea Club, c/o Angie Papp, 620 Payne Road, New Albany, Indiana 47150, USA

J.S.O. Ayeni, Kainji Lake Research Institute, P.M.B. 666, New Bussa, Kwara State, Nigeria
A. Ben-David, 5, Azar Street, Holon 58291, Israel
G.S. Brah, Department of Animal Science, Punjab Agricultural University, Ludhiana 141 004, India
X. Colonna C., 14 Cotham Road, Bristol BS6 6DR, UK
N.I. Dim, Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria
R. Dumont, Ecole Nationale SupTrieure des Sciences Agronomiques AppliquTes, 26, boulevard Docteur Petitjean 21100 Dijon, France
R. Etches, Department of Animal and Poultry Science, University of Guelph, Guelph, Ontario NIG 2WI, Canada
D. Holderread, P.O. Box 492, Corvallis, Oregon 97339, USA
A.F. Hutton, Garaina Farms, Scrubby Creek Road, Gympie MS: 115, Queensland 4570, Australia
D.N. Johnson, Natal Parks, Game and Fish Preservation Board, P.O. Box 661, Pietermaritzburg 3200, South Africa
S.D. Lukefahr, International Small Livestock Research Center, Department of Food Science and Animal Industries, Alabama A&:M University, P.O. Box 264, Normal, Alabama 35762, USA
W. Michie, Poultry Husbandry Division, North of Scotland College of Agriculture, Parkhead, Craibstone, Bucksburn, Aberdeen AB2 9SX, Scotland, UK
P. Mongin, Station de Recherches Avicoles, I.N.R.A., Nouzilly, 37380 Monnaie, France
S. Ochetim, School of Agriculture, University of the South Pacific, Alafua Campus, Apia, Western Samoa

A.N. Okaeme, Wildlife/Range Division, Kainji Lake Research Institute, P.M.B. 666, New Bussa, Kwara State, Nigeria
J.S. Sandhu, Poultry Breeder, Department of Animal Science, Punjab Agricultural University, Ludhiana 141 004, India
B.K. Shingari, Department of Animal Science, Punjab Agricultural University, Ludhiana 141 004, India
R.G. Somes, Nutritional Sciences, Box U-17, University of Connecticut, Storrs, Connecticut 06268, USA
R.T. Wilson, Bartridge House, Umberleigh, North Devon EX37 9AS, UK

Muscovy

R.E. Abdelsamie, Department of Biochemistry, Microbiology, and Nutrition, University of New England, Armidale, New South Wales 2351, Australia
G.P. Bilong, Department of Primary Industry, Monogastric Research Centre, P.O. Box 73, Lae, Papua New Guinea
J.K. Camoens, Asian Development Bank, P.O. Box 789, Manila 2800, Philippines
H. de Carville, Station de Recherches Avicoles, I.N.R.A., Centre de Tours, Nouzilly 37380, Monnaie, France
F.D. Chesterley, 4502 Loomis Trail, Blaine, Washington 98230, USA
X. Colonna C., 14 Cotham Road, Bristol BS6 6DR, UK
N.I. Dim, Animal Science Department, Faculty of Agriculture, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria
R. Dumont, Ecole Nationale SupTrieure des Sciences Agronomiques AppliquTes, 26, boulevard Docteur Petitjean 21100 Dijon, France
G.R. Gerona, Department of Animal Science and Veterinary Medicine, Visayas State College of Agriculture, Baybay, Leyte, Philippines

Barry Glofcheskie, Department of Environmental Biology, University of Guelph, Guelph, Ontario NIG 2WI, Canada (fly control)
D. Holderread' P.O. Box 492, Corvallis, Oregon 97339, USA
W.F. Hollander, Route 4, Box 168, Ames, Iowa 50010, USA
E. Hoffmann, Canning, Nova Scotia BOP IH0, Canada
C.H. Huang, Food and Fertilizer Technology Center for the Asian and Pacific Region, Fifth Floor, 14 Wenchow Street, Taipei, Taiwan (mule duck)
G.A.R. Kamar, Animal Production Department, Faculty of Agriculture, Cairo University, Giza, Egypt
W. Michie, Poultry Husbandry Division, North of Scotland College of Agriculture, Parkhead, Craibstone, Bucksburn, Aberdeen AB2 9SX, Scotland, UK
Donald E. Mock, Department of Extension Entomology, 239 Waters Hall, Kansas State University, Manhattan, Kansas 66506-4004, USA (fly control)
P. Mongin, Station de Recherches Avicoles, I.N.R.A., Nouzilly 37380 Monnaie, France
S. Ochetim, School of Agriculture, University of the South Pacific, Alafua Campus, Apia, Western Samoa
H. Pingel, Karl Marx Universitat, Sektion TV, Lehrstuhl Geflugel- und Pelztierzucht, 7010 Leipzig, Stephanstrasse 12, Germany
B. Retailleau, Grimaud FrFres S.A., La CorbiFre, 494S0 Roussay, France
I. Romboli, Le Quericole, Universita Delgi Studi di Pisa 56010 S. Piero A Grado, Italy
T.S. Sandhu, Cornell University Duck Research Laboratory, P.O. Box 217, Eastport, New York 11941, USA
G.A. Surgeoner, Department of Environmental Biology, University of Guelph, Guelph, Ontario NIG 2WI, Canada (fly control)

C. Tai, Taiwan Livestock Research Institute, 112 Farm Road Shin-hua. Tainan, Taiwan 71210
R.T. Wilson, Bartridge House, Umberleigh, North Devon EX37 9AS, UK

Pigeon

A.O. Aduku, Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria
D.O. Alonge, Meat Hygiene and Preservation Laboratory, Faculty of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria
J.K. Camoens, Asian Development Bank, P.O. Box 789, Manila 2800, Philippines
K.M. Cheng, Avian Genetics Laboratory, Department of Animal Science, University of British Columbia, Vancouver, British Columbia V6T 2A2, Canada
R. Dillinger, 3201 Huffman Boulevard, Rockford, Illinois 61103, USA
N.I. Dim, Animal Science Department, FacultyofAgriculture, AhmaduBello University, P.M.B. 1044, Zaria, Nigeria
R.O. Hawes, Department of Animal and Veterinary Sciences, University of Maine, Orono, Maine 04469, U.S.A.
D. Holderread, P.O. Box 492, Corvallis, Oregon 97339, USA (carrier pigeons)
W.F. Hollander, Route 4, Box 168, Ames, lowa 5001O, USA
M.A. Latif, Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, Bangladesh
Y. Le HTnaff, Laboratoire de l'H(pital Avranches, Avranches, Cotentin, France (carrier pigeons)
S.D. Lukefahr, International Small Livestock Research Center, Department of Food Science and Animal Industries, Alabama A&M University, P.O. Box 264, Normal, Alabama 35762, USA

G.A.R. Kamar, Animal Production Department, Faculty of Agriculture, Cairo University, Giza, Egypt
W.J. Miller, Department of Genetics, Iowa State University, Ames, Iowa 50011, USA
G. Owen, 6520 Wiscasset Road, Bethesda, Maryland 20816, USA
G. Pena PTrez, Apartado Postal 23, La Nucia, Alicante, Spain
E. Ross, Department of Animal Science, University of Hawaii, Honolulu, Hawaii 96822, USA
M.D. Roush, Green Valley Squab Farm, 1348 Green Valley Road, Folsom, California 9563O, USA
T.S. Sandbu, Cornell University Duck Research Laboratory, P.O. Box 217, Eastport, New York 11941, USA
J.S. Sim, Department of Animal Science, University of Alberta, Edmonton, Alberta TOG 2P5, Canada
R.T. Wilson, Bartridge House, Umberleigh, North Devon EX37 9AS, UK

Quail

Many people raise Japanese quail. Probably the best way to locate a local source is to consult local pet stores, the county farm advisor's office, university faculty of agriculture, game-bird fanciers, and the like. Finding people with local research experience is usually most useful to beginners. Coturnix International, Inc., is a nonprofit organization with primary interests in promoting small domesticated food animal production for both youth training and improved nutrition. The use of coturnix (Japanese quail) for these purposes is already well established in a number of Michigan schools and in the Dominican Republic, with special emphasis on science projects, especially where nutritional inadequacies exist. The address

is Coturnix International Inc., International Headquarters, 1111 Michigan Avenue, Box 250O, East Lansing, Michigan 48823, USA. Avian Sciences Department, University of California, Davis, California 95616, USA

J.K. Camoens, Asian Development Bank, P.O. Box 789, Manila 2800, Philippines
K.M. Cheng, Avian Genetics Laboratory, Department of Animal Science, University of British Columbia, Vancouver, British Columbia V6T 2A2, Canada
D.E. Deppner, Trees for the Future, 11306 Estona Drive, Silver Spring, Maryland 20902, USA
D. Holderread, P.O. Box 492, Corvallis, Oregon 97339, USA
S.D. Lukefahr, International Small Livestock Research Center, Department of Food Science and Animal Industries, Alabama AOcM University, P.O. Box 264, Normal, Alabama 35762, USA
H.L. Marks, Genetics Unit, Room 107 Livestock-Poultry Building, University of Georgia, Athens, Georgia 30602, USA
A. Marsh, Marsh Farms, 7171 Patterson Drive, Garden Grove, California 92641, USA
H. Martoyo, Faculty of Animal Science, Institut Pertanian Bogor, Jalan Raya Pajajaran, Bogor, West Java, Indonesia
Z. Abidin bin Mohd Noor, Department of Veterinary Services, Jalan Sultan Salahuddin, 50630 Kuala Lumpur, Malaysia (chicken-quail hybrids)
P.K. Pani, Indian Veterinary Research Institute, Izatnagar 243 122, Bareilly, Uttar Pradesh, India
H. Pingel, Karl Marx Universitat, Sektion TV, Lehrstuhl Geflugel- und Pelztierzucht, 7010 Leipzig, Stephanstrasse 12, Germany
D. Polin, Department of Animal Science, Michigan State University, East Lansing, Michigan 48824, USA

C.V. Reddy, Faculty of Veterinary Science, Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad 500 030, India
Rodale Research Center, RD #1, Box 323, Kutztown, Pennsylvania 19530, USA
E. Ross, Department of Animal Science, University of Hawaii, Honolulu, Hawaii 96822, USA
B.K. Shingari, Department of Animal Science, Punjab Agricultural University, Ludhiana 141 006, India
R.G. Somes, Nutritional Sciences, Box U-17, University of Connecticut, Storrs, Connecticut 06268, USA
R. Tempest, Heifer Project International, P.O. Box 808, Little Rock, Arkansas 72203, USA
S. K. Varghese, Department of Animal Science, Michigan State University, East Lansing, Michigan 48824-1225, USA
N. Wakasugi, Laboratory of Animal Genetics, Nagoya University, Furo-cho, Chikusaku, Nagoya, Japan
H.R. Wilson, Poultry Science Department, Archer Road, University of Florida, Gainesville, Florida 32611, USA

Turkey

M. Berruecos V. Muz, Facultad de Medicina Veterinaria y Zootecnia, Ciudad Universitaria, Mexico D.F., Mexico
R.D. Crawford, Department of Animaland Poultry Science, UniversityofSaskatchewan, Saskatoon, Canada
M. Cuca G., Institucion de Ensenanza e Investigacion en Ciencias Agricolas, Colegio de Postgraduados, Chapingo, Mexico
K.E. Nestor, Ohio Agricultural Research and Development Center, Ohio State

University, Wooster, Ohio
H. Pingel, Karl-Marx-Universitat, Sektion TV, Lehrstuhl Geflugel- und Pelztierzucht, 7010 Leipzig, Stephanstrasse 12, Germany
M.L. Scott, 16 Spruce Lane, Ithaca, New York 14850, USA
H.J. Sexton, Agricultural Research Service, U.S. Department of Agriculture, Beltsville Agricultural Research Center, Building 262, Beltsville, Maryland 20705, USA
R.G. Somes, Nutritional Sciences. Box U-17, University of Connecticut, Storrs, Connecticut 06268, USA

Potential New Poultry

J.E. Duckett, P.O. Box 12378, 50776 Kuala Lumpur, Malaysia (barn owls)
W.R. Marion, Department of Wildlife and Range Science, University of Florida, Gainesville, Florida 32611, USA (chachalaca)
C. Smal, Wildlife Service, Sidmonton Place, Bray County, Wicklow, Ireland (barn owls)

RABBITS

Domestic Rabbit

A.O. Aduku, Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria
J. Baranga, Department of Zoology, Makerere University, P.O. Box 7062, Kampala, Uganda
M. Baselga, Departamento de Ciencia Animal, Escuela TTcnica Superior de

Ingenieros Agronomos, Camino de Vera 14, 46022 Valencia, Spain
C. de Blas, Departamento Alimentacion Animal, Escuela TTcnica Superior de Ingenieros Agronomos, Ciudad Universitaria, 28040 Madrid, Spain
J.A. Castell6, Real Escuela Oficial y Superior de Avicultura (REOSA), Calle Plana Parafso, s/n Arenys de Mar, Barcelona, Spain
C.B. Chawan, International Small Livestock Research Center, Department of Food Science and Animal Industries, Alabama A&M University, P.O. Box 264, Normal, Alabama 35762, USA
P.R. Cheeke, Rabbit Research Center, Department of Animal Science, Oregon State University, Corvallis, Oregon 97331, USA
S. Fekete, University of Veterinary Science, Department of Animal Nutrition, Budapest, Pf.2, H-1400 Hungary
J. Fernandez C., Departamento de Ciencia Animal, Escuela TTcnica Superior de Ingenieros Agronomos, Universidad PolitTcnica de Valencia, Camino de Vera, 14, 46022 Valencia, Spain
C. Cervera Fras, Departamento de Ciencia Animal, Universidad PolitTcnica de Valencia, Apartado 22012, Valencia, Spain
D.J. Harris, Pel-Freez Rabbit Meat, Inc., P.O. Box 68, Rogers, Arkansas 72756, USA
J.A.B. Hundleby, Ciskei Agricultural Corporation Ltd., P.O. Box 59, Bisho, Ciskei, South Africa
D.L. Huss, P.O. Box 426, Menard, Texas 76859, USA
R. de Jong, Department of Tropical Animal Production, Marykeweg 40, 6709 P.G. Wageningen, The Netherlands
L.A. Kamwanja, Bunda College of Agriculture, University of Malawi, P.O. Box 219, Lilongwe, Malawi
M. Leyun, Instituto TTcnico Gesti6n Porcino (ITGP), Seccion Conejos, Ctra. del

Sadar, s/n 31006 Pamplona (Navarra), Spain
H. Loliger, Lisztstrasse 20, 3100 Celle, Germany
S.D. Lukefahr, International Small Livestock Research Center, Department of Food Science and Animal Industries, Alabama A&M University, P.O. Box 264, Normal, Alabama 35762, USA
T.P.E. Makhambera, Bunda College of Agriculture, University of Malawi, P.O. Box 219, Lilongwe, Malawi
J.I. McNitt, Center for Small Farm Research, Southern University, P.O. Box 11170, Baton Rouge, Louisana 70813-1170, USA
M. Mgheni, Sokoine University of Agriculture, Animal Science and Production Department, P.O. Box 3004, Morogoro, Tanzania
K. Mitchell, Baptist Bible Institute, P.O. Box 301, Basseterre, St. Kitts, West Indies
G.A. Norman, Tropical Products Institute, Culham, Abingdon, Oxfordshire OX14 3DA, UK
L.N. Odonker, P.O. Box 11, Tsito-Awudome, Volta Region, Ghana
O.C. Onwudike, Department of Animal Science, University of Ife, Ile-Ife, Nigeria
G.G. Partridge, Rowett Research Institute, Bucksburn, Aberdeen AB2 9SB, Scotland, UK
N.M. Patton, Rabbit Research Center, Oregon State University, Corvallis, Oregon 97331, USA
M.J. Paya, Departamento de Microbiologia, Facultad de Veterinaria, Avenida Puerta de Hierro, Ciudad Universitaria, 28040 Madrid, Spain
T. PTrez, Departamento de Reproduccion Animal, Instituto Nacional de Investigaciones Agrarias (INIA), Avenida Puerta de Hierro, s/n, 28040 Madrid, Spain
H.L. Polley, Programme DTveloppement Plateau Bateke, CBZO, B.P. 4728, Kinshasa

2, Zaire
R. Ramchurn, School of Agriculture, University of Mauritius, RTduit, Mauritius
T.E. Reed, Box 98, Markle, Indiana 46770, USA
E. Respaldiza, Instituto Nacional de Investigaciones Agrarias (INIA), Departamento de Higiene y Sanidad Animal, Calle Embajadores, 68, 28012 Madrid, Spain
B. Retailleau, Grimaud FrFres S.A., La CorbiFre, 49450 Roussay, France
A. Rodriguez, Departamento Microbiologia e Inmunologia, Facultad de Veterinaria, Calle Miguel Servet, numero 117, 50013 Zaragoza, Spain
R. Rodriguez de L., "Conejos" Centro de Investigacion Cientifica del Estado de MTxico A.C., Camino a Huexotla No. 5, San Miguel Coatlinchan, 56170 Texcoco, Estado de MTxico, Mexico
W. Schlolaut, Hessen Institute for Animal Production, Neu-Ulrichstein, 6313 Homberg, West Germany
W.D. Semuguruka, Department of Veterinary Pathology, Faculty of Veterinary Medicine, Sokoine University of Agriculture, P.O. Box 3018, Chuo Kikuu Morogoro, Tanzania
I. Sierra, Departamento Produccion Animal, Facultad de Veterinaria, Calle Miguel Servet, numero 117, 50013 Zaragoza, Spain
R. Valls, Institut de Recerce i Tecnologia Agroalimentaria (IRTA), Torre Marimon, 08140 Caldes de Montbui, Barcelona, Spain
P. Zaragoza, Departamento de Genetica y Mejora, Facultad de Veterinaria, Calle Miguel Servet, numero 117, 50013 Zaragoza, Spain

RODENTS

Agouti

C.J.R. Alho, Departamento de Biologia Animal, Universidade de Brasilia, 70910 Brazilia, DF, Brazil
R.H. Baker, 302 North Strickland Street, Eagle Lake, Texas 77434-1841, USA
H. Bonilla Encizo, ICA Tibaitata, Apartado Aereo 151123, BogotG, Colombia
A.D. Cuaron O., Instituto de Historia Natural, Apartado Postal No. 6, Tuxtla Gutierrez, Chiapas 29000, Mexico
L.A. Deutsch, Parque Zoologico de Sao Paulo, SGo Paulo, Brazil
G. Dubost, Laboratorie d'Ecologie, 4 avenue Petit ChGteau, 91800 Brunoy, France
J.K. Frenkel, Department of Pathology, University of Kansas Medical Center, Kansas City, Kansas 66013, USA
A. Escajadillo, Gorgas Memorial Laboratory, P.O. Box 935, APO Miami, Florida 340020012, USA OR Avenida Justo Arosemena 34-30, Apartado 6991, Panama 5, Panama
W. Hallwachs, Department of Biology, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6018, USA
G. Hislop, Wildlife Section, Forest Division, Ministry of Food Production, Port-ofSpain, Trinidad and Tobago
S. Ingrand, I.N.R.A., Campus agronomique, B.P. 709, 97387 Kourou Cedex, French Guiana
D.H. Janzen, Department of Biology, University of Pennsylvania, Philadelphia, Pennsylvania 19104, USA
D. Kleiman, National Zoological Park, Washington, D.C. 20008, USA
A. Lavorenti, Animal Sciences Department, ESALQ Universidade de Sao Paulo, C.P. 9, Piracicaba, Sao Paulo 13.400, Brazil
D.A. Meritt, Jr., 2200 North Cannon Drive, Chicago, IHinois 60614, USA
J.R. de Alencar Moreira, EMBRAPA-CPATU, Agricultural Research Center of the

Humid Tropics, Caixa Postal 48, BelTm, Para 66000, Brazil
C.Ma. Rojas G., CATIE, 7170 Turrialba, Costa Rica
G. Santos, Fundatao Parque Zoologico de Sao Paulo, Sao Paulo, Brazil
N. Smith, Department of Geography, University of Florida, Gainesville, Florida 32611, USA
N. Smythe, Smithsonian Tropical Research Institute, Box 2072, Balboa, Panama
O. Sousa, Department of Microbiology, Cinuad Universitaria "Dr Octavio MTndez Pereira," El Cangregio, Apartado Estafeta Universitaria, Panama City, Panama
A.B. Taber, Animal Behaviour Research Group, Department of Zoology, South Parks Road, Oxford OXI 3PS, UK
E. Wing, Florida State Museum, University of Florida, Gainesville, Florida 32611, USA
C.A. Woods, Florida State Museum, University of Florida, Gainesville, Florida 32611, USA

Capybara

C.J.R. Alho, Departamento de Biologia Animal, Universidade de Brasilia, 70910 Brasilia, DF, Brazil
K.P. Bland, Department of Veterinary Physiology, Royal (Dick) School of Veterinary Studies, Summerhall, Edinburgh EH9 IQH, Scotland, UK
H. Bonilla Encizo, ICA Tibaitata, Apartado Aereo 151123, Bogota, Colombia
P.R. Cheeke, Rabbit Research Center, Department of Animal Science, Oregon State University, Corvallis, Oregon 97331, USA
T.J. Cunha, P.O. Box R, LaVerne, California 91750, USA
J.F. Eisenberg, Florida State Museum, University of Florida, Gainesville, Florida 32611, USA

F. Golley, Institute of Ecology, University of Georgia, Athens, Georgia 30601, USA
E. Gonzalez-Jimenez, Facultad de Agronomia, Universidad Central de Venezuela, Maracay, Venezuela
H. Hemmer, Institute of Zoology, Johannes Gutenberg University, Anemonenweg 18, D-6500 Mainz-Ebersheim, Germany
J.A. Howarth, School of Veterinary Medicine, University of California, Davis, California 95616, USA
S. Ingrand, I.N.R.A., Campus agronomique, B.P. 709, 97387 Kourou Cedex, French Guiana
N. Konnerup, 74 North Sunrise Boulevard, Camano Island, Washington 98292, USA
J.E. Jackson, Terraza Turrado 80, 5730 Villa Mercedes, San Luis, Argentina
D. Kleiman, National Zoological Park, Washington, D.C. 20008, USA
A. Lavorenti, Animal Sciences Department, ESALQ Universidade de Sao Paulo, C.P. 9, Piracicaba, Sao Paulo 13.400, Brazil
R.D. Lord, Biology Department, Indiana University of Pennsylvania, Indiana, Pennsylvania 15705, USA
D.W. MacDonald, Animal Behaviour Research Group, Department of Zoology, South Parks Road, Oxford OXI 3PS, UK
J.R. de Alencare Moreira, Agricultural Research Center of the Humid Tropics, EMBRAPA-CPATU, Caixa Postal 48" BelTm, Para 66000, Brazil
B. Muller-Haye, Food and Agricultural Organization of the United Nations, Room F524, Via delle Terme di Caracalla, 00100 Rome, Italy
J. Ojasti, Institute of Tropical Zoology, Apartado 47058, Universidad Central de Venezuela, Caracas 1041A, Venezuela
N.L. Rondon, Departamento de Engenharia Florestal, Centro de Ciencias Agrarias, Universidada Federal de Mato Grosso, Cuiaba-MT, 78000, Brazil

N. Smith, Department of Geography, University of Florida, Gainesville, Florida 32611, USA
A.E. Sollod, Section of International Veterinary Medicine, Tufts University, 200 Westboro Road, North Grafton, Massachusetts 01536, USA
F. Sunquist, Route 1, Box 1434, Melrose, Florida 32666, USA
A.B. Taber, Animal Behaviour Research Group, Department of Zoology, South Parks Road, Oxford OXI 3PS, UK
K.D. Thelen, FAO Regional Of fice for Latin America and the Caribbean, CasiHa 10095, Santiago, Chile
D. Wharton, New York Zoological Society, Bronx, New York 10460, USA
E. Wing, Florida State Museum, University of Florida, Gainesville, Florida 32611, USA

Coypu

A.C. Carmichael, The Museum, Michigan State University, East Lansing, Michigan 48824-1045, USA
G. Chapman, Utah State University, Logan, Utah 84322, USA
L. Contreras, Universidad Cat61ica de Valpariso, Avenida Brasi. 295O, Casilla 4059, Valparaiso, Chile
D. Huss, P.O. Box 426, Menard, Texas 76859, USA
H.-G. Klos, Zoologischer Garten Berlin, Aktiengesellschaft, Hardenbergplatz, 1000 Berlin 30, Germany
P. Lutz, Rosenstiel School of Marine and Atmospheric Science, Biology and Living Resources, University of Miami, 4600 Rickenbacker Causeway, Miami, Florida 33149, USA
J.R. de Alencar Moreira, Agricultural Research Center of the Humid Tropics, Caixa

Postal 48, BelTm, ParG, 66000, Brazil
J. Szumiec, Experimental Fish Culture Station, Polish Academy of Sciences, Golysz 43-422 Chybie, Poland
C.A. Woods, Florida State Museum, University of Florida, Gainesville, Florida 32611, USA

Giant Rat

Animal Research Institute, Council for Scientific and Industrial Research (CSIR), P.O. Box 20, Achimota, Chana
J. Baranga, Department of Zoology, Makerere University, P.O. Box 7062, Kampala, Uganda
K.P. Bland, Department of Veterinary Physiology, Royal (Dick) School of Veterinary Studies, Summerhall, Edinburgh EH9 IQH, Scotland, UK
P. Brinck, Ecology Building, Department of Animal Ecology, University of Lund, S223 62 Lund, Sweden
G. Dubost, Laboratorie d'Ecologie, 4 avenue Petit ChGteau, 91800 Brunoy, France
D. Fielding, Centre for Tropical Veterinary Medicine, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush, Roslin, Midlothian EH25 9RG, Scotland, UK
D.C.D. Happold, Department of Zoology, Australian National University, Canberra, Australian Capital Territory 2601, Australia
J.C. Heymans, BP 1910, Cotonou, Benin
J.A. Kamara, c/o Njala University College, Private Mail Bag, Freetown, Sierra Leone
M.H. Knight, Kalahari Gemsbok Park, Private Bag X5890, Upington 8800, South Africa
M. Malekani, DTpartement de Biologie, FacultT des Sciences, UniversitT de

Kinshasa, B.P. 190, Kinshasa XI, Zaire
R.W. Matthewman, Centre for Tropical Veterinary Medicine, Royal (Dick) School for Veterinary Studies, University of Edinburgh, Easter Bush, Roslin, Midlothian EH25 9RG, Scotland, UK
A.J. Smith, Centre for Tropical Veterinary Medicine, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush, Roslin, Midlothian EH25 9RG, Scotland, UK

Grasscutter

A. Alexander, Department of Biology, Natal University, King George V Avenue, Durban 4001, South Africa
E.O.A. Asibey, Department of Game and Wildlife, Ministry Post Office, Accra, Ghana
E.S. Ayensu, African Development Bank, 01 B.P. No. 1837, Abidjan 01, Ivory Coast
R. Baptist, Institute for Animal Production in the Tropics and Subtropics, University of Hohenheim (480), P.O. Box 700562, D-7000 Stuttgart 70, Germany
S.Y. Bimpong-Buta, Council for Law Reporting, P.O. Box M165, Accra, Ghana
P. Brinck, Department of Animal Ecology, University of Lund, Ecology Building, S223 62, Lund, Sweden
H. Dosso, Institut d'Ecologie Tropicale, Abidjan, Ivory Coast
D. Fielding, Centre for Tropical Veterinary Medicine, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush, Roslin, Midlothian EH25 9RG, Scotland, UK
D.C.D. Happold, Department of Zoology, Australian National University, Canberra, Australian Capital Territory 2601, Australia
J. Hardouin, Institut de Medicine Tropicale "Prince Leopold," Nationalestraat 155, B2000 Antwerp, Belgium

J.C. Heymans, BP 1910, Cotonou, Benin
A. Hutton, Garaina Farms, Scrubby Creek Road, Gympie MS:115, Queensland 4570, Australia
J.A. Kamara, c/o Njala University College, Private Mail Bag, Freetown, Sierra Leone
Laboratoire Centrale de Nutrition Animale (LACENA), B.P. 353, Abidjan 06, Ivory Coast
S.D. Lukefahr, International Small Livestock Research Center, Department of Food Science and Animal Industries, Alabama A&M University, P.O. Box 264, Normal, Alabama 35762, USA
R.-P. Mack, Projet BTnino-Allemand Conseiller Technique auprTs du MDRAC, BP 504, Cotonou, Benin
G.H.G. Martin, Department of Zoology, Kenyatta University College, P.O. Box 43844, Nairobi, Kenya
R.W. Matthewman, Centre for Tropical Veterinary Medicine, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush, Roslin, Midlothian EH25 9RG, Scotland, UK
G.A. Mensah, Responsable PBAA (Projet BTnino-Allemand d'Aulacodiculture), P.B. 2359, Cotonou, Benin
T.A. Omole, Department of Animal Science, University of Ife, Ile-Ife, Nigeria
K.J. Peters, International Livestock Centre for Africa (ILCA), P.O. Box 5689, Addis Ababa, Ethiopia
F. Petter, MammifFres et Oiseaux, Museum National d'Histoire Naturelle Zoologie, 55 rue de Buffon 75005, Paris, France
W. Schr(der, Institute of Animal Breeding, Albrecht-Thaer-Weg 1, 3400 Gottingen, Germany
A.J. Smith, Centre for Tropical Veterinary Medicine, Royal (Dick) School of

Veterinary Studies, University of Edinburgh, Easter Bush, Roslin, Midlothian EH25 9RG, Scotland, UK
D.W. Thomas, Department of Biology, University of Sherbrooke, Sherbrooke, Quebec JIK 2RI, Canada
St. von Korn, Institute of Animal Breeding, Albrecht-Thaer-Weg 1, 3400 G(ttingen, Germany
J. Walder, Presbyterian Rural Training Centre, P.O. Box 72, Bamenda, NW Province, Cameroon

Guinea Pig

G.P. Bilong, Department of Pimary Industry, Monogastric Research Centre, P.O. Box 73, Lae, Papua New Guinea
K.P. Bland, Department of Physiology, Royal (Dick) School of Veterinary Studies, Summerhall, Edinburgh EH9 IQH, Scotland, UK
R. Bolton, Department of Anthropology, Pomona College, Claremont, California 91711, USA
H. Bonilla Encizo, ICA Tibaitata, Apartado Aereo 151123, Bogota, Colombia
J.K. Camoens, Asian Development Bank, P.O. Box 789, Manila 2800, Philippines
A. Del Carpio R., Facultad de Zootecnia, Universidad Nacional "Pedro Ruiz Gallo," Calle Atahualpa No. 179, Apartado 48, Lambayeque, Peru
P.R. Cheeke, Rabbit Research Center, Department of Animal Science, Oregon State University, Corvallis, Oregon 97331, USA
T.J. Cunha, P.O. Box R, LaVerne, California 91750, USA
J. Descailleux, Laboratorio GenTtica Humana, C.P. 11010, Lima 14, Peru
J.A. Ferguson, Overseas Development Administration, Eland House, Stug Place, London, UK

D. Fielding, Centre for Tropical Veterinary Medicine, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush, Roslin, Midlothian EH25 9RC, Scotland, UK
J.K. Frenkel, Department of Pathology, University of Kansas Medical Center, Kansas City, Kansas 66013, USA
J. Hardouin, Institut de MTdecine Tropicale "Prince Leopold," Nationalestraat IS5, B2000 Antwerpen, Belgium
R.E. Honegger, Zurich Zoo, Zurichbergstrasse 221, CH-8044 Zurich, Switzerland
J. Howarth, School of Veterinary Medicine, University of Calffornia, Davis, Calffornia 95616, USA
D.L. Huss, P.O. Box 426, Menard, Texas 76859, USA
J.E. Jackson, Terraza Turrado 80, 5730 Villa Mercedes, San Luis, Argentina
C. Jenkins, PNG Institute Medical Research, P.O. Box 60, Goroka, Eastern Highlands Province, Papua New Guinea
R. de Jong, Department of Tropical Animal Production, Marykeweg 40, 6709 PG Wageningen, The Netherlands
J.A. Kamara, c/o Njala University College, Private Mail Bag Freetown, Sierra Leone
P.J. Kohun, Department of Agriculture, PNG University of Technology, Lae, Papua New Guinea
N.M. Konnerup, 74 North Sunrise Boulevard, Camano Island, Washington 98292, USA
T.E. Lacher, Jr., Huxley College of Environmental Studies, Western Washington University, Bellingham, Washington 98225, USA
S.D. Lukefahr, International Small Livestock Research Center, Department of Feed Science and Animal Industries, Alabama A&M University, P.O. Box 264, Normal, Alabama 35762, USA

R.C. Malik, Department of Agriculture, PNG University of Technology, Lae, Papua New Guinea
R.W. Matthewman, Centre for Tropical Veterinary Medicine, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush, Roslin, Midlothian EH25 9RG, Scotland, UK
A.R. Moreno, Departamento de Produccion Animal, Universidad Nacional Agraria, Apartado 456, La Molina, Lima, Peru
B. Muller-Haye, Food and Agriculture Organization of the United Nations, Room F524, Via delle Terme di Caracalla, 00100 Rome, Italy
H.L. Polley, Programme DTveloppement Plateau Bateke, CBZO, B.P. 4728, Kinshasa 2, Zaire
V. Purizaga A., Alcalde del Concejo Provincial de Pacasmayo, Dos de Mayo 360, Peru
V.T. Quirante, Bureau of Animal Industry, Research Center, Alabang 3124, Metro Manila, Philippines
C.V. Reddy, Faculty of Veterinary Science, Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad 500 030, India
O.W. Robinson, Department of Animal Science, North Carolina State University, Box 7621 Raleigh, North Carolina 27695-7621, USA
A.J. Smith, Centre for Tropical Veterinary Medicine, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush, Roslin, Midlothian EH25 9RG, Scotland, UK
D. Wharton, New York Zoological Society, Bronx, New York 10460, USA
E. Wing, Florida State Museum, University of Florida, Gainesville, Florida 32611, USA

Hutia

A.C. Allen, Hope Zoo, Kingston, Jamacia
R.S. Canet, Instituto de Zoologla, Academia Ciencias de Cuba, Calle 214, esq. a Avenida 19, No. 17A 09, Reparto Atabey, Havana 16, Cuba
D. Kleiman, National Zoological Park, Washington, D.C. 20008, USA
K. Jordan, Department of Zoology, University of Florida, Gainesville, Florida 32611, USA
W.L.R. Oliver, Jersey Wildlife Preservation Trust, Les AugrFs Manor, Jersey, Channel Islands, UK
J.A. Ottenwalder, Parque Zool6gico Nacional (ZOODOM), Apartado 2449, Santo Domingo, Dominican Republic
E. Wing, Florida State Museum, University of Florida, Gainesville, Florida 32611, USA
C. Woods, Florida State Museum, University of Florida, Gainesville, Florida 32611, USA

Mara

L.T. Blankenship, Animal Resources Center, School of Medicine, East Carolina University, Greenville, North Carolina 27858-4354, USA
G. Dubost, Laboratoire d'Ecologie, 4 avenue Petit ChGteau, 91800 Brunoy, France
J.E. Jackson, Terraza Turrado 80, 5730 Villa Mercedes, San Luis, Agentina
D. Kleiman, National Zoological Park, Washington, D.C. 20008, USA
D.W. MacDonald, Animal Behaviour Research Group, Department of Zoology, South Parks Road, Oxford OXI 3PS, UK
W.H. Pryor, Jr., School of Medicine, East Carolina University, Greenville, North Carolina 27858-4354, USA
A.B. Taber, Animal Behaviour Research Group, Department of Zoology, South

Parks Road, Oxford OXI 3PS, UK

Paca

J.R. de Alencar Moreira, Agricultural Research Center of the Humid Tropics, EMBRAPA-CPATU, Caixa Postal 48, BelTm, Para 66000, Brazil
C.J.R. Alho, Departamento de Biologia Animal, Universidade de Brasilia, 70910 Brasilia, DF, Brazil
R.H. Baker, 302 North Strickland Street, Eagle Lake, Texas 77434-1841, USA
A.D. Cuardn O., Instituto de Historia Natural, Apartado Postal No. 6, Tuxtla Gutierrez, Chiapas 29000, Mexico
G. Dubost, Laboratoire d'Ecologie, 4 avenue Petit ChGteau, 91800 Brunoy, France
L. de Escalante, Zool6gico Nacional, Direccion del Patrimonio Natural y Cultural, San Salvador, El Salvador
J.K. Frenkel, Department of Pathology, University of Kansas Medical Center, Kansas City, Kansas 66013, USA
W. Hallwachs, Ecology and Systematics, Corson Hall, Cornell University, Ithaca, New York 14853, USA
C. Hislop, Wildlife Section, Forest Division, Ministry of Food Production, Port-ofSpain, Trinidad and Tobago
D.H. Janzen, Department of Biology, University of Pennsylvania, Philadelphia, Pennsylvania 19104, USA
D. Kleiman, National Zoological Park, Washington, D.C. 20008, USA
A. Lavorenti, Animal Sciences Department, ESALQ Universidade de Sao Paulo, C.P. 9, Piracicaba, Sao Paulo 13.400, Brazil
Y. Matamoros, Escuela de Medicina Veterinaria, Universidad Nacional, Apartado 86, Heredia, Costa Rica

D. Meritt, Jr., 2200 North Cannon Drive, Chicago, Illinois 60614, USA
C.Ma. Rojas G., CATIE, 7170 Turrialba, Costa Rica
O. Rosado, Ministry of Industry and Natural Resources, Belmopan, Belize
N. Smith, Department of Geography, University of Florida, Gainesville, Florida 32611, USA
N. Smythe, Smithsonian Tropical Research Institute, Box 2072, Balboa, Panama
V. Solis, Union Internacional pare la Conservacion de la Naturaleza y de los Recursos Naturales, Oficina Regional pare Centro AmTrica, Apartado Postal 91-1009-FECOSA, San JosT, Costa Rica
S. VaidTs, Centro Universitario del Norte Carrera ZootTcnica, Coban, A.V., Ciudad Guatemala 16001, Guatemala
E. Wing, Florida State Museum, University of Florida, Gainesville, Florida 32611, USA

Vizcacha

H. Bonilla Encizo, ICA Tibaitata, Apartado Aereo 151123, Bogota, Colombia
J.E. Jackson, Terraza Turrado 80, 5730 Villa Mercedes, San Luis, Argentina
E.L. Marmillon, Estancias del Conlara S.A., Casilla de Correo 451, 5800 Rio Cuarto, Argentina
K.D. Thelen, FAO Regional Office for Latin America and the Caribbean, Casilla 10095, Santiago, Chile
E. Wing, Florida State Museum, University of Florida, Gainesville, Florida 32611, USA

Other Rodents

T.M. Butynski, Impenetrable Forest Conservation Project, Zoology Department, Makerere University, P.O. Box 7062, Kampala, Uganda (springhare)
T. Flannery, Australian Museum, 6-8 College Street, Sydney, New South Wales 2000, Australia (Solomon Island rodents)
Inter-African Bureau for Animal Resources, Maendeleo House, Monrovia Street, POB 30786, Nairobi, Kenya (springhare)
N. Jacobsen, Nature Conservation Division, Private Bag X209, Pretoria 0001, South Africa (springhare)
C.P. Kofron, Museum of Zoology, Louisiana State University, Baton Rouge, Louisiana 70893, USA (springhare)
T. Leary, Ministry of Natural Resources, Honiara, Solomon Islands (Solomon Island rodents)
C.A. McLaughlin, San Diego Zoo, San Diego 92112, California, USA (springhare)
R.P. Millar, Department of Chemical Pathology, Medical School, Observatory 7925, South Africa (springhare)
J.D. Skinner, Mammal Research Institute, University of Pretoria, Pretoria 0002, South Africa (springhare)
Southern African Wildlife Management Association, POB 413, Pretoria, South Africa (s p ring hare)
L. Talbot, 6656 Chitton Court, McLean, Virginia 22101, USA (springhare)
M. Van der Merwe, University of Pretoria, Mammal Research Institute, Pretoria 0002, South Africa (springhare)
Wildlife Society of Zimbabwe, POB 3497, Harare, Zimbabwe (springhare)

DEER AND ANTELOPE

Mouse Deer

J.O. Caldecott, World Wildlife Fund Malaysia, 7 Jalan Ridgeway, 93200 Kuching, Sarawak, Malaysia
R. Chaplin, Burnhouse, Fountainhall, Galashiels, Selkirk TDI 2RX, UK
G.W.H. Davison, Zoology Department, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
G. Dubost, Laboratoire d'Ecologie GTnTrale, 4 avenue Petit ChGteau, 91800 Brunoy, France
P. Grubb, 35 Downhills Park Road, London N17 6PE, UK
Liu Ruiqing, Kunming Institute of Zoology, Academia Sinica, Kunming, Yunnan Province, People's Republic of China
M. MacNamara, Fauna Research, Inc., 11 Park Avenue, Ardsley, New York 10502, USA
I. Muul, Integrated Conservation Research, P.O. Box 920, Harpers Ferry, West Virginia 25425, USA
M. Nordin, Bureau of Research and Consultancy, University Kebangsaan Malaysia, Bangi, Selangor, Malaysia
S. Pathak, Department of Genetics, M.D. Anderson Hospital and Tumor Institute, Houston, Texas 77030, USA
C.T. Robbins, Wildlife Biology Program, Washington State University, Pullman, Washington 99164-4220, USA
K. Robin, Tierpark Dahlholzli Bern, Dalmaziquai 149, CH-3005 Bern, Switzerland
C.R. Schmidt, Zoological Garden, CH-8044 Zurich, Switzerland
R.A. Sirimanne, Singapore Zooological Gardens, 80 Mandai Lake Road, Singapore 2572
L. Talbot, 6656 Chilton Court, McLean, Virginia 22101, USA
M.K. Vidyadaran, Faculty of Veterinary Science, Department of Animal Science,

Universiti Pertanian Malaysia, Serdang 43400, Selangor, Malaysia
Wang Yingxiang, Kunming Institute of Zoology, Academia Sinica, Kunming, Yunan Province, People's Republic of China
D. Wharton, New York Zoological Society, Bronx, New York 10460, USA
G.C. Whittow, Department of Physiology, John A. Burns School of Medicine, University of Hawaii, 1960 East West Road, Honolulu, Hawaii 96822, USA

Muntjac

C. Barrette, DTpartement de Biologie, Facult� des Sciences et de GTnie, Universit� Laval, QuTbec, GIK 7P4, Canada
K. Benirschke, 8457 Prestwick Drive, La Jolla, California 92037, USA
The British Deer Society, Church Farm, Lower Basildon, Reading, Berkshire RG8 9NH, UK
J.O. Caldecott, World Wildlife Fund Malaysia, 7 Jalan Ridgeway, 933200 Kuching, Sarawak, Malaysia
N. Chapman, Larkmead, Barton Mills, Bury St. Edmunds, Suffolk IP28 6AA, UK
M. Coe, Department of Zoology, University of Oxford, South Parks Road, Oxford OXI 3PS, UK
O. Dansie, The Chapel, 2 Hobbs Hall, Welwyn, Hertsfordshire, UK
S.K. Dhungal, Department of Parks and Wildlffe, P.O. Box 860, Kathmandu, Nepal
C. Dubost, Laboratoire d'Ecologie GTnTrale, 4 avenue Petit ChGteau, 91800 Brunoy, France
R.J. Goss, Division of Biology and Medicine, Brown University, Providence, Rhode Island 02912, USA
C.P. Groves, Department of Prehistory and Anthropology, Australian National University, P.O. Box 4, Canberra, Australian Capital Territory 2600, Australia

P. Grubb, 35 Downhills Park Road, London N17 6PE, UK
S.P. Harding, Animal Ecology Research Group, Zoology Department, South Parks Road, Oxford OX1 3PS, UK
S. Harris, Department of Zoology, University of Bristol, Woodland Road, Bristol BS8 JUG, UK
H. Heck, CatskiH Game Farm, Inc., RD #1, Box 133, Catskill, New York 12414, USA
H.A. Jacobson, Fish and Wildlffe Department, Mississippi State University, Mississippi State, Mississippi 39762, USA
Liu Ruiqing, Kunming Institute of Zoology, Academia Sinica, Kunming, Yunnan Province, People's Republic of China
Lu Houji, Department of Biology, East China Normal University, Shanghai 200062, People's Republic of China
M. MacNamara, Fauna Research, Inc., 11 Park Avenue, Ardsley, New York 10502, USA
V.J.A. Manton, Zoological Society of London, Whipsnade Park, Dunstable, Bedfordshire LU6 2LF, UK
S. Miura, Department of Biology, Hyogo College of Medicine, Mukogawa-cho 1-1, Nishinomiya, Hyogo-ken 663, Japan
I. Muul, Integrated Conservation Research, P.O. Box 920, Harpers Ferry, West Virginia 25425, USA
S. Pathak, Department of Genetics, M.D. Anderson Hospital and Tumor Institute, Houston, Texas 77030, USA
C.T. Robbins, Wildlife Biology Program, Washington State University, Pullman, Washington 99164, USA
B. Seidel, Tierpark Berlin, Tierklinik, DDR-1136 Berlin, Friedrichsfelde, Germany
Shi Liming, Kunming Institute of Zoology, Academia Sinica, Kunming, Yunnan

Province, People's Republic of China
H. Soma, Department of Obstetrics and Gynecology, Tokyo Medical College Hospital, 1-7, Nishishinjuku 6, Shinjuku-ku, Tokyo 160, Japan
S. Stadler, Fakultat fur Biologie, Universitat Bielefeld, 4800 Bielefeld, Universitatsstrasse 25, Germany
L. Talbot, 6656 Chilton Court, McLean, Virginia 22101, USA
P.F. Taylor, Taylor Energy Company, The 2-3-4 Loyola Building, New Orleans, Louisiana 70112, USA
Wang Yingziang, Kunming Institute of Zoology, Academia Sinica, Kunming, Yunnan Province, People's Republic of China
C. Wemmer, Conservation and Research Center, National Zoological Park, Front Royal, Virginia 22630, USA
D. Wharton, New York Zoological Society, Bronx, New York 10460, USA
D.M. Wurster-HiH, Department of Pathology, Dartmouth Medical School, Hanover, New Hampshire 03755, USA
R.H. Yahner, 320 Forest Resources Laboratory, Pennsylvania State University, University Park, Pennsylvania 16802, USA

Musk Deer

R. Chaplin, Burnhouse, Fountainhall, Galashiels, Selkirk TDI 2RX, UK
S.K. Dhungel, Department of Parks and Wildlife, P.O. Box 860, Kathmandu, Nepal
A.J. Gaston, Canadian Wildlife Service, Ottawa KIA OE7, Canada
C.P. Groves, Department of Prehistory and Anthropology, Australian National University, P.O. Box 4, Canberra, Australian Capital Territory 2600, Australia
M.J.B. Green, IUCN Conservation Monitoring Centre, 219C Huntingdon Road, Carnbridge CB3 ODL, UK

P. Grubb, 35 Downhills Park Road, London N17 6PE, UK
M.L. Hunter, Jr., Wildlife Department, University of Maine, Orono, Maine 04469, USA
H.A. Jacobson, Fish and Wildlife Department, Mississippi State University, Mississippi State, Mississippi 39762, USA
B. Kattel, P.O. Box 3070, Kathmandu, Nepal
Liu Riqing, Kunming Institute of Zoology, Academia Sinica, Kunming Yunnan Province, People's Republic of China
Lu Houji, Department of Biology, East China Normal University, Shanghai 200062, People's Republic of China
J. McNeely, Program and Policy Division, International Union for Conservation of Nature and Natural Resources, Avenue du Mont-Blanc, CH1196 Gland, Switzerland
B.W. O'Gara, Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, Montana 59812, USA
C.T. Robbins, Wildlife Biology Program, Washington State University, Pullman, Washington 99164-4220, USA
B. Seidel, Tierpark Berlin, Tierklinik, DDR-1136 Berlin, Friedrichsfelde, Germany
Shi Liming, Kunming Institute of Zoology, Academia Sinica, Kunming, Yunnan Province, People's Republic of China
P.F. Taylor, Taylor Energy Co., The 2-3-4 Loyola Building, New Orleans, Louisiana 70112, USA
Wang Yingxiang, Kunming Institute of Zoology, Academia Sinica, Kunming, Yunnan Province, People's Republic of China

Water Deer

A. Cooke, Nature Conservancy Council, Northminster House, Peterborough PEI I

UA, UK
L. Farrell, Nature Conservancy Council, Northminster House, Peterborough PEI IUA, UK
F. Feer, Laboratoire d'Ecologie GTnTrale, 4 avenue Petit ChGteau, 91800 Brunoy, France
P. Crubb, 35 Downhills Park Road, London N17 6PE, UK
Liu Riuqing, Kunming Institute of Zoology, Academia Sinica. Kunming Yunnan Province, People's Republic of China
Lu Houji, Department of Biology, East China Normal University, Shanghai 200062, People's Republic of China
V.J.A. Manton, Zoological Society of London, Whipsnade Park, Dunstable, Bedfordshire LU6 2LF, UK
B. Seidel, Tierpark Berlin, Tierklinik DDR-1136, Berlin, Friedrichsfelde, Germany
R Smith, Department of Zoology, Whiteknights Park, University of Reading, Reading, Berkshire RG6 2AH, UK
S. Stadler, Fakultat fur Biologie, Universitat Bielefeld, 4800 Bielefeld, Universitats strasse 25, Germany
P.F. Taylor, Taylor Energy Company, The 2-3-4 Loyola Building, New Orleans, Louisiana 70112, USA
C. Wemmer, Conservation and Research Center, National Zoological Park, Front Royal, VA 2263O, USA

South American Microdeer

M. Sampath, Trinidad and Tobago Wildlffe Breeders and Farmers Association, c/o 5 3/4 Mile Mark, Penal Rock Road, Penal, Trinidad, West Indies (red brocket)
M. MacNamara, Fauna Research, Inc., 11 Park Avenue, Ardsley, New York 10502,

USA (pudu)

Duikers

J. Baranga, Department of Zoology, Makerere University, P.O. Box 7062, Kampala, Uganda
B. Chardonnet, Projet Petits Ruminants, B.P. 65, Atakpame, Togo
R.L. Cowan, 324 Henning Building, Pennsylvania State University, University Park, Pennsylvania 16802, USA
G. Dubost, Laboratoire d'Ecologie GTnTrale, 4 avenue Petit ChGteau, 91800 Brunoy, France
RI.M. Dunbar, Department of Zoology, University of Liverpool, P.O. Box 147, Liverpool L69 3BX, UK
F. Feer, Laboratoire d'Ecologie GTnTrale, 4 avenue Petit ChGteau, 91800 Brunoy, France
K.R. Kranz, Zoological Society of Philadelphia, 34th Street and Girard Avenue, Philadelphia, Pennsylvania 19104, USA
S. Lumpkin, Department of Zoological Research, National Zoological Park, Washington, D.C. 20008, USA
I. Player, Wilderness Leadership School, P.O. Box 15036, BeHair 4006, Natal, South Africa
K. Pond, Department of Animal Science, North Carolina State University, Box 7621, Raleigh, North Carolina 27695, USA
S. Schweers, Bahnhofstrasse 29, D-6744 Kandee, Germany
J.D. Skinner, Mammal Research Institute, University of Pretoria, Pretoria 0002, South Africa
A.E. SoHod, International Veterinary Medicine, Tufis University, 200 Westboro

Road, North Grafion, Massachusetts 01536, USA
L. Talbot, 6656 Chilton Court, McLean, Virginia 22101, USA
C.C. Udell, 14934 VaHey Vista Blouvard, Sherman Oaks, Calffornia 91403, USA
G.A. Varga, Department of Dairy and Animal Science, 225B Borland Laboratory, Pennsylvania State University, University Park, Pennsylvania 16802, USA
V.J. Wilson, Duiker Research and Breeding Centre, Chipangali Wildlife Trust, P.O. Box 1057, Bulawayo, Zimbabwe

Other Small Antelope

L. Asibey, Department of Game and Wildlife, Ministry Post Office, Accra, Ghana
J. Baranga, Department of Zoology, Makerere University, P.O. Box 7062, Kampala, Uganda
J.I. Boshe, College of African Wildlife Management, Mweka, P.O. Box 3031, Moshi, Tanzania (dikdik)
B. Chardonnet, Project Petits Ruminants, BP 65, Atakpame, Togo (oribi)
S.K. Dhungel, Department of National Parks and Wildlife, Conservation, Babar Mahal, Kathmandu, Nepal (four-horned antelope)
R.I.M. Dunbar, Department of Zoology, University of Liverpool, P.O. Box 147, Liverpool L69 3BX, UK (dikdik, klipspringer)
F. Feer, Laboratoire d'Ecologie GTnTrale, 4 avenue Petit ChGteau, 91800 Brunoy, France
A.M. Goebel, Department of Biology, University of Texas at Arlington, Arlington, Texas 76019, USA
P.P. Hoppe, Am Hauenstein 13, 6706 Wachenheim, Germany (dikdik, suni)
K.R. Kranz, Zoological Society of Philadelphia, 34th Street and Girard Avenue, Philadelphia, Pennsylvania 19104, USA (royal antelope, beira, dikdik, klipspringer,

suni, four-horned antelope)
I. Player, Wilderness Leadership School, P.O. Box 15036, Bellair 4006, Natal, South Africa
E.N.W. Oppong, UNDP/FGN/FAO Livestock Project, P.O. Box 6603, Jos, Plateau State, Nigeria
W.R. Pritchard, School of Veterinary Medicine, University of California, Davis, California 95616, USA
J. Skinner, Mammal Research Institute, University of Pretoria, Pretoria 0002, South Africa (otibi, steinbok)
A.E. Sollod, International Veterinary Medicine, Tufts University, 200 Westboro Road, North Grafton, Massachusetts 01536, USA (dikdik, klipspringer)
L. Talbot, 6656 Chilton Court, McLean, Virginia 22101, USA (dikdik, klipspringer, four-horned antelope)

LIZARDS

Green Iguana

K. Benirschke, 8457 Prestwick Drive, La Jolla, California 92037, USA
G.M. Burghardt, Department of Psychology, University of Tennessee, Knoxville, Tennessee 37996, USA
A. Ferreira, Parque Zoologico Nacional, Apartado 2449, Santo Domingo, Dominican Republic
H.S. Fitch, Route #3, Box 142, Lawrence, Kansas 66044, USA
G. Hemley, World Wildlife Fund, 1255 23rd Street, N.W., Washington, D.C. 20037, USA (for trade information)
R.W. Henderson, Milwaukee Public Museum, 800 West Wells Street, Milwaukee,

Wisconsin 53233 USA
J. Higginson, Voluntaria del Cuerpo de Paz, #156 6a Avenida 1-46, Zona 2 Guatemala, Guatemala
J.B. Iverson, Department of Biology, Earlham College, Richmond, Indiana 47374, USA S.R. Kellert, School of Forestry and Environmental Studies, Yale University, 205 Prospect Street, New Haven, Connecticut 06511, USA
F.W. King, Florida State Museum, University of Florida, Gainesville, Florida 32601, USA
G. Larde, Ministerio de Agricultura y Ganaderia Planes de Renderos, Km. 10 Col. Los Angeles 13, CP 01196 San Salvador, El Salvador
D. Marcellini, National Zoological Park, Washington, D.C. 20008, USA
J.M. Mora, 200 m sur Pulperia la Uni6n, Cinco Esquinas, Carrieal, Alajuela, Costa Rica
J.A. Ottenwalder, Parque Zool6gico Nacional, Apartado 2449, Santo Domingo, Dominican Republic
G.C. Packard, Department of Zoology, Colorado State University, Fort Collins, Colorado 80523, USA
J.J. Perez, Condominio Su. Antonio 7, C. San Antonio Abad, San Salvador, El Salvador
J. Phillips, Research Department, San Diego Zoo, Box 551, San Diego, Calffornia 92112, USA
D. Werner, Fundacion Pro Iguana Verde, Apa,-tado 1501-3000, Heredia, Costa Rica

Black Iguana

H.S. Fitch, Route #3, Box 142, Lawrence, Kansas 66044, USA
R.W. Henderson, Milwaukee Public Museum, 800 West Wells Street, Milwaukee,

Wisconsin 53233, USA
J. Higginson, Voluntaria del Cuerpo de Paz, #156 6a Avenida 1-46, Zona 2 Guatemala, Guatemala
D.M. Hillis, Department of Biology, University of Miami, Coral Gables, Florida 33124, USA
G. Larde, Ministerio de Agricultura y Ganaderia, Planes de Renderos Km. 10 Col. Los Angeles 13, CP 01196, San Salvador, El Salvador
D. Marcellini, National Zoologica, Park, Washington, D.C. 20008, USA
J.M. Mora, 200 m sur Pulperita La Union, Cinco Esquinas, Carrieal, Alajuela, Costa Rica
G.C. Packard, Department of Zoology, Colorado State University, Fort Collins, Colorado 80523, USA
J.J. Perez, Condominio Su. Antonio 7, C. San Antonio Abad, San Salvador, El Salvador
J. Phillips, Research Department, San Diego Zoo, Box 551, San Diego, Calffornia 92112, USA
D. Werner, Fundacion Pro Iguana Verde, Apartado 1501-3000, Heredia, Costa Rica

Rock Iguana

W. Auffenberg, Florida State Museum, University of Florida, Gainesville, Florida 32611, USA
D. Auth, Florida State Museum, University of Florida, Gainesville, Florida 32611, USA
T.J. Cullen, Cullen Vivarium, 3401 South 16th Street, Milwaukee, Wisconsin 53215 USA
A. Ferreira, Parque Zool6gico Nacional, Apartado 2449, Santo Domingo, Dominican

Republic
R.W. Henderson, Mi]waukee Public Museum, 800 West Wells Street, Milwaukee, Wisconsin 53233, USA
J.B. Iverson, Department of Biology, Earlham College, Richmond, Indiana 47374, USA
J.A. Ottenwalder, Parque Zool6gico Nacional, Apartado 2449, Santo Domingo, Dominican Republic
T.A. Wiewandt, Wild Horizons, Inc., P.O. Box 5118, Tucson, Arizona 85703, USA

Tegu

C.A. Blanco, Direccion Nacional de Fauna Silvestre, Avenida Paseo Colon 922 2°piso, (1063) Buenos Aires, Argentina
O.K. Donadio, Museo Argentino de Ciencias Naturales, CC 220, Avenida Angel Gallardo 470, Suc. 5, 1405 Buenos Aires, Argentina
J.M. Gallardo, Museo Argentino de Ciencias Naturales, CC 220, Avenida Angel Gallardo 470, Suc. 5, 1405 Buenos Aires, Argentina
G. Hemley, World Wildlife Fund, 1255 23rd Street, N.W., Washington, D.C. 20037, USA
D. Marcellini, National Zoological Park, Washington, D.C. 20008, USA
E.L. Marmillon, Casilla de Correo 451, 5800 Rio Cuarto, Argentina
G.C. Packard, Department of Zoology, Colorado State University, Fort Collins, Colorado 80523, USA
D. Werner, Fundacion Pro Iguana Verde, Apartado 1501-3000, Heredia, Costa Rica

BEES

Local Agriculture Extension Services and beekeepers are often the best source of information for beginning beekeeping. In addition, the following organizations can provide information: International Bee Research Association, 16/18 North Road, Cardiff CF1 3DY, UK; International Agency for Apiculture Development, 6N 909 Roosevelt, St. Charles, Illinois 60174, USA

I. Abt, Centre for International Agricultural Development Cooperation, Tel Aviv, Israel M. Adey. International Bee Research Association, 16/18 North Road, Cardiff CFI 3DY, UK
S.O. Adjare, Technology Consultancy Centre, University of Science and Technology, Kumasi, Ghana
All India Beekeepers' Association, 817 Sadashiv Peth, Poono 411 030, India
S.K.N. Atuahene, Forest Product Research Institute (Ghana Forestry Commission), University P.O. Box 63, Kumasi, Ghana
H.S. Brar, Department of Entomology, Punjab Agricultural University, Ludhiana 141 004, India
N. Bradbear, International Bee Research Association, North Road, Cardiff CFI 3DY, UK
D.M. Caron, Department of Entomology and Applied Ecology, University of Delaware, Newark, Delaware 19717, USA
B.S. Chahal, Department of Entomology, Punjab Agricultural University, Ludhiana 141 004, India
B. Clauss, Beekeeping Survey, Kabompo, Zambia
M.P. Coleman, International Agency for Apiculture Development, 6N 909 Roosevelt, St. Charles, Illinois 60174, USA
Director, or Resident Bee Specialist, Apiary Studies, Zoological Institute, Leningrad, USSR

D. DeJong, Departamento de Genetica, Faculdade de Medicina de Ribeirao Preto, Universidade Sao Paulo, 14.049-Ribeirao Preto, Sao Paulo, Brazil
R.W. Dutton, Centre for Overseas Research and Development (CORD), University of Durham, South Road, Durham DHI 3LE, UK (Apisflorea)
E.H. Erickson, Carl Hayden Bee Research Center, Agricultural Research Service, U.S. Department of Agriculture, 2000 East Allen Road, Tucson, Arizona 85719, USA
Faculdade de Medicina de Ribeirao Preto, Departamento de GenTtica, 14100-Ribeirao Preto, Sao Paulo, Brazil
R.D. Fell, Virginia Polytechnic Institute, Blacksburg, Virginia 24061, USA
K. Flottum, Gleanings in Bee Culture, 623 West Liberty Street, P.O. Box 706, Medina, Ohio 44258-0706, USA (editor)
J. Free, Rothamstead Experimental Station, Harpenden, Hertfordshire L5 2JQ, UK
D. Wolde-Semait Gebre-Wold, P.O. Box 7505, Addis Ababa, Ethiopia
C.B. Habarugira, AHO (Apiary), Mbara Stockfarm, Beekeeping Section, P.O. Box 4, Mbarara, Uganda
L.A.M. Hassan, Njiro Wildlife (Beekeeping) Research Centre, P.O. Box 661, Arusha, Tanzania
R. Hoopingarner, Department of Entomology, University of Michigan, East Lansing, Michigan 48824-1115, USA
W.E. Kerr, Departamento de Biolgia, Universidade Federal de UberlGndia, 38400 UberlGndia, Brazil
P.G. Kevan, or Resident Bee Specialist, Department of Environmental Biology, University of Guelph, Guelph, Ontario NIG 2WI, Canada
K.K. Kigatiia, Beekeeping Branch, Ministry of Agriculture c~ Livestock Development, P.O. Box 30028, Nairobi, Kenya
H.C. Killins, 163 Trowbridge Avenue, London, Ontario N6J 3M2, Canada

H.M. Kiwuwa, AHL (Apiary), Department of Veterinary Services, Headquarters, Beekeeping Section, P.O. Box 7141, Kampala, Uganda
G. Lanarolle, Apiculture Project, Bindunuwewa, Bandarawela, Sri Lanka
Y. Lensky, Triwaks Bee Research Center, Hebrew University Faculty of Agriculture, Rehovot 76-100, Israel
M.D. Levin, Carl Hayden Bee Research Center, Agricultural Research Service, U.S. Department of Agriculture, 2000 East Allen Road, Tucson, Arizona 85719, USA
M. Singh Limbu, Godavari Ashram, GPO Box 50, Kathmandu, Nepal
I. Mann, 14 Millimani Road, Box 20360, Nairobi, Kenya
R.J. McGinley, Department of Entomology, NHB-105, Smithsonian Institution, Washington, D.C. 20560, USA (Apoidea, except Apis)
J. McKay, Peace Corps, American Embassy, Asunci6n, Paraguay
C.D. Michener, Snow Entomological Museum, University of Kansas, Lawrence, Kansas 66045, USA
R.A. Morse, Department of Entomology, Cornell University, Ithaca, New York 14853, USA
J. Morton, Morton Collectanea, University of Miami, Box 248204, Coral Gables, Florida 37724, USA (bee plants)
D.G. Mugisa, c/o Insure Consult, P.O. Box 30002, Nakiuubo, Uganda
M. Bin Muid, Department of Plant Protection, Faculty of Agriculture, Universiti Pertanian Malaysia, Serdang 43400, Selangor, Malaysia
H.C. Mulzac, International Agency for Apiculture Development, 393 Decatur Street, Brooklyn, New York 11233, USA
K.S. Najar, Faculty of Agriculture, University of Aleppo, Aleppo, Syria
B.E. Nightingale, Box 23, Njoro, Kenya
G. Patty, Foreign Agriculture Service, U.S. Department of Agriculture, 6095 South

Building, Washington, D.C. 20250, USA
L.M. Phiri, Office of Chief Beekeeping Officer, P/BAC Mwekera, Kitwe, Zambia
R. Pickard, Zoology Department, University College, P.O. Box 78, Cardiff CFI IXL, South Wales, UK
G.W. Robins, GPO Box 50, Kathmandu, Nepal
D. Roubik, Stop 105, Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560, USA (stingless bees)
D. Sammataro, 7011 Spieth Road, Medina, Ohio 44256, USA (editor, Cornucopia)
G. Schechtel, Cnel. Bogado/Itapua, Paraguay
H. Shimanuki, Beneficial Insects Laboratory, Agricultural Research Service, U.S. Department of Agriculture, B-476 BARC-East, Beltsville, Maryland 20705, USA
O.R. Taylor, Department of Entomology, University of Kansas, Lawrence, Kansas 66045, USA
J.E. Tew, Agricultural Technical Institute, Ohio State University, Wooster, Ohio 44691, USA
M. Tomasko, Pennsylvania State University, 106 Patterson Building, University Park7 Pennsylvania 16802, USA
P. Torchio, Agricultural Research Service, U.S. Department of Agriculture, Bee Laboratory, Utah State University, Logan, Utah 84322-5310, USA
R. Wadlow, 8381 San Mateo, Ft. Myers, Florida 33907, USA
D.W. Whitehead, International Agency for Apiculture Development, c/o 1000 Connecticut Avenue NW, #707, Washington, D.C. 20036, USA
Siriwat Wongsiri, Department of Biology, Chulalongkorn University, Bangkok7 Thailand (Apis cerana)
Wu Yan-ru, Department of Insect Taxonomy and Faunistics, Institute of Zoology, Academia Sinica, 7 Zhongguancun Lu, Haitien, Beijing, People's Republic of China

C BIOGRAPHICAL SKETCHES OF PANEL MEMBERS

RALPH W. PHILLIPS retired in 1982 from the post of deputy director general of the Food and Agriculture Organization of the United Nations (FAO), Rome, Italy, a post he held for four years. Among his earlier posts were that of professor and head, Animal Husbandry Department, Utah State University; senior animal husbandman in charge, Genetic Investigations, United States Department of Agriculture (USDA); chief, Animal Production Branch and deputy director, Agriculture Division, FAO; and executive director, International Organization Affairs, USDA. Among his special assignments were: serving as consultant on animal breeding to the governments of China and India for the U.S. Department of State in 1943-44; and as scientific secretary for agriculture of the United Nations Conference on Science and Technology for the Benefit of Developing Countries, in Ceneva, Switzerland, 1962-63. Dr. Phillips holds a B.S. degree in agriculture from Berea College (1930), M.A. (1931) and Ph.D. (1934) degrees from the University of Missouri, and Honorary D.Sc. degrees from Berea College and West Virginia University. He has been awarded the Berea College Distinguished Alumnus Award and the USDA's Distinguished Service Award. He is author or coauthor of some 240 scientific papers, review papers, chapters in books, and books on various aspects of physiology of reproduction, genetics, livestock production, and international agriculture. In his research, writings, and international activities, Dr. Phillips has given particular attention to breeding in relation to the environment and to the identification and conservation of valuable animal genetic resources. He is also the author of a definitive history of FAO entitled FAO: Its Origins, Formation and Evolution, 19451981 and an autobiography, The World Was My Barnyard.

EDWARD S. AYENSU is currently senior advisor to the president of the African

Development Bank. He is also president of ESA Associates, Washington, D.C., and former director of the Office of Biological Conservation, Smithsonian Institution, Washington, D.C. A citizen of Ghana, he received his B.A. in 1961 from Miami University in Ohio, M.Sc. from The George Washington University in 1963, and his Ph.D. in 1966 from the University of London. His research interests cover many areas of tropical biology. An internationally recognized expert on topics relating to science, technology, and development, especially in developing countries, he has also published extensively on tropical plants. Dr. Ayensu chairs and serves as a member of many international bodies.

BONNIE V. BEAVER, professor of small animal medicine and surgery, Texas A&M University, College Station, is a specialist in animal behavior and problem behaviors, especially in domestic and laboratory animals. She received her B.S. and D.V.M. from the University of Minnesota and her M.S. from Texas A&M. In addition to being a popular speaker at scientific meetings, she is the author of five books and numerous book chapters and articles.

KURT BENIRSCHKE, professor of pathology and reproductive medicine, University of California at San Diego, received his M.D. from the University of Hamburg, Germany, in 1948. He served on the faculties of Harvard and Dartmouth medical schools before coming to San Diego in 1970. At the San Diego Zoo he initiated a research department to advance knowledge in endangered species and now serves as a trustee of that organization. He has written on comparative mammalian cytogenetics, vanishing species, and human reproductive pathology.

ROY D. CRAWFORD is professor of animal and poultry genetics at the University of Saskatchewan, Saskatoon, Saskatchewan, Canada. He received his B.S.A. from the University of Saskatchewan in 1955, his M.S. in animal genetics from Cornell University in 1957, and his Ph.D. in poultry genetics from the University of

Massachusetts in 1963. He was employed as a scientist with the Research Branch of Agriculture Canada from 1957 to 1964 in Prince Edward Island and Nova Scotia. He joined the faculty of the University of Saskatchewan in 1964. He was made a fellow of the Agricultural Institute of Canada in 1986 in recognition of his teaching and research work. His research interests include single gene genetics of poultry, and conservation of genetic resources in poultry and livestock. He has discovered and studied many mutants in chickens; some of them have biomedical importance, including one shown to be an animal genetic model of human grand mal epilepsy; some of them are potentially useful in food production, including an albinism mutant that is being developed for autosexing of commercial chicken broilers. He maintains a very large conservation collection of poultry genetic resources at the University of Saskatchewan and has prepared an inventory and assessment of Canada's poultry and livestock genetic resources. Dr. Crawford is a member of the Expert Panel on Animal Genetic Resources Conservation and Management, FAO/UNEP, Rome, and is a member of the Animal Resources Committee, Canadian Council on Animal Care, Ottawa. He serves on the International Scientific Committee for the French journal GTnTtique, STlection, +volution. He is a member of the Rare Breeds Survival Trust (UK) and is a board member of the American Minor Breeds Conservancy (USA).

TONY J. CUNHA, distinguished service professor emeritus, University of Florida, Gainesville, and dean emeritus, California State Polytechnic University, Pomona, received his Ph.D. at the University of Wisconsin in 1944. He has given more than 100 lectures in livestock feeding and nutrition in 40 foreign countries. He served as chairman of the Animal Nutrition Committee of the National Academy of Sciences and as a member of the NAS-NRC Board of Agriculture and Renewable Resources, Latin American Science Board, and as chairman of the livestock

committee of two world food studies by NAS-NRC. He served as a member of the organizing committee for the first two World Conferences on Animal Production in Rome (1963) and Washington, D.C. (1968). He served as a member of the Title XII Board of International Food and Agricultural Joint Committee on Research and as chairman of its research priorities committee 1977-1981. He is author, editor, coeditor, or contributor to 30 books and author of more than 1,423 scientific and professional articles. He is a winner of 42 campus, state, national, and international honors and awards.

DAVID E. DEPPNER, director of Trees for the Future in Silver Spring, Maryland, has been a consultant for international development projects involving livestock and poultry management and marketing for the past 14 years. He has served in 17 countries of Asia, Africa, and Central America. He has written on processing livestock rations under tropical conditions and about the Madurese breed of cattle found in East Java, Indonesia, where he spent two years studying this ancient breed. He is currently providing technical assistance to projects in several countries for the development of improved forage production as an answer to destruction of natural resources of tropical uplands caused by overgrazing. He received his B.Sc. in animal science from Ohio State University in 1954 and M.Sc. in livestock economics from Araneta University, the Philippines, in 1977.

ELIZABETH L. HENSON is the director of the American Minor Breeds Conservancy, based in Pittsboro, North Carolina. She received an M.A. in zoology from Oxford University in 1980 and an M.Sc. in domestic animal breeding from Edinburgh University in 1981. Her primary interests are in the conservation of rare and endangered breeds and varieties of domestic livestock as a genetic resource for changing agricultural needs. She represented Britain at the first international conference on domestic animal conservation in Hungary in 1982, and was a

member of the Office of Technology Assessment Committee on grassroots strategies to maintain genetic diversity in 1985. She is executive secretary for four British breed associations and is a member of the British Rare Breeds Survival Trust Technical Panel.

DONALD L. HUSS was regional animal production officer of the FAO Regional Office for Latin America and the Caribbean, Santiago, Chile, before his retirement. He received a B.S. in 1949, an M.A. in 1954, and a Ph.D. in 1959, all at Texas A&M University. He was assistant professor of range management at Texas A&M before joining the Food and Agricultural Organization of the United Nations (FAO) in 1967. He founded the FAO Regional Office's Small Animals for Small Farms programme in 1980. Professional assignments and travels in Latin America, the Caribbean' Near and Middle East, and Africa have contributed to his knowledge and experience in microlivestock development. Dr. Huss was recognized by Texas A&M University by being chosen as the recipient of the Memorial Student Center Appreciation and Distinguished Service Awards in 1958 and 196O, respectively, and Honour Professor in the College of Agriculture in 1966 67. He also received the Society for Range Management's Outstanding Service and Achievement Award in 1975 and its Fellow Award in 1978.

DAVID RICHARD LINCICOME has been a guest scientist with the Animal Parasitology Institute, United States Department of Agriculture Experiment Station, Beltsville, Maryland, since 1978, having retired as professor of parasitology, Howard University, Washington, D.C., in 1970. He received the B.S. and M.S. degrees cum laude simultaneously in 1937 from the University of Illinois and a Ph.D. in tropical medicine from the Tulane Medical School, New Orleans, Louisiana, in 1941. His principal research interests have centered around morphologic studies on Acanthocephala, molecular exchanges of dependent cells

and their environments, and diagnosis of parasitic diseases. He has been a breeder of Nubian and American pygmy goats for the past 20 years. Dr. Lincicome is currently a member of the Board of Directors of the American Dairy Goat Association and is past president of the National Pygmy Goat Association. He was founder and long time trustee of the American Dairy Goat Association Research Foundation. He is also past president of the Helminthological Society and currently serves the society as archivist. He received the Helminthological Society's Anniversary Award in 1975. He was founder and, for 27 years, editor of the journal Experimental Parasitology, and is the author and editor of more than 180 scientific contributions.

THOMAS E. LOVEJOY is a tropical biologist and ornithologist. He is assistant secretary for external affairs, Smithsonian Institution' Washington, D.C. He was formerly executive vice president for the World Wildlife Fund-U.S., chairman of the Wildlife Preservation Trust International, and a member of two commissions of the International Union for the Conservation of Nature and Natural Resources. At present, Dr. Lovejoy is a principal investigator of the world's largest controlled ecological experiment, which is attempting to determine the optimum size for parks and reserves. This project, conceived and designed by Dr. Lovejoy, is called "the Minimum Critical Size of Ecosystems" and is a joint program of World Wildlife Fund-U. S. and Brazil's National Institute for Amazon Research. Dr. Lovejoy is also the principal advisor for NATURE (WNET/THIRTEEN, New York), a series that he started in 1980. As principal advisor, he recommends program content and oversees the factual accuracy of the program scripts. A member of 11 scientific societies, Dr. Lovejoy has received grants from 16 foundations and institutions and written more than 100 articles for various national and International publications. He has published three books, Key Environments,

Pergamon Press, Oxford; Nearctic Avian Migrants in the Neotropics, a Department of the Interior publication; and Conservation of Tropical Forest Birds, an ICPB publication. He is currently working on The Magnificent Exception, a book on people and the biosphere.

ARNE W. NORDSKOG is professor emeritus, Department of Animal Science, Iowa State University. He received his B.S., M.S., and Ph.D. degrees from the University of Minnesota between 1937 and 1943. His training and principal area of research has been in quantitative genetics, but by about 1960 his interests shifted to immunogenetics and more recently to molecular genetics. He has traveled widely, spending two years as an instructor in agriculture at the University of Alaska (1937-39), and has been an NSF Research Fellow at Cal Tech (1960), a visiting professor at the University of Minnesota (1966), an FAO lecturer at the Indian Veterinary Institute (1973), and an FAO-sponsored lecturer on poultry breeding in China (1979). He has acted as a consultant to a commercial breeder in Japan for 20 years. He has been the major professor at Iowa State for more than 60 M.S. and Ph.D. candidates and has published more than 150 scientific papers. Dr. Nordskog is an honorary member of the Norwegian Poultry Breeding Association, a fellow of the Poultry Science Association, and a fellow of the AAAS. In 1972, he was the recipient of the Poultry Science Distinguished Service Research Award.

LINDA M. PANEPINTO, swine research consultant, was director of the Colorado State University Swine Laboratory through 1988. She earned her B.S. in animal sciences at Colorado State University in 1972. In 1973 she joined the research team developing Yucatan miniature swine at Colorado State University, where she was given primary responsibility for colony management, protocol development, and genetic selection programs. In 1977, she designed an experimental research program for the development of a line of Yucatan pigs with a genetic propensity

for exceptionally small size. She has continued her work in that area and has developed the Yucatan Micropig, described elsewhere in this publication. Her other major professional area of interest has been the design of facilities and equipment for swine with emphasis on animal comfort and minimizing stress. Her invention, known as the Panepinto Sling, has been widely adopted as the primary restraint method for numerous medical schools and research facilities using swine in the laboratory. She has published extensively in the field.

KURT J. PETERS is professor of animal breeding and husbandry in the tropics and subtropics, University of Gottingen, and is currently director of research at the International Livestock Centre for Africa. He received his Dr. Agr. degree from the Technical University of Berlin in 1975. He has undertaken research in livestock production development in Southeast Asia and Africa. The major focus of his research has been small animals, with special attention given to the potential of unconventional animals. Early in 1985 he assumed his present position directing research at the International Livestock Centre for Africa.

JOHN A. PINO is a senior fellow of the National Research Council, Board on Agriculture, and is currently the project director of the study "Managing Global Genetic Resources: Agricultural Imperatives." He received his B.S. in agriculture in 1944-47 and Ph.D. in zoology in 1951 from Rutgers University. As an associate professor he taught and did research in the Department of Poultry Science at Rutgers until 1955 when he accepted a position with the Rockefeller Foundation as animal scientist with the Mexican Agricultural Program, becoming the associate director of that program in 1960. In 1965 he was transferred to the Rockefeller headquarters in New York and became director of the Agricultural Science Program in 1970. Most of his career has been in international agricultural development. He retired from the Foundation in 1983 and went to Washington to

become agricultural science advisor at the InterAmerican Development Bank until July 1986 when he accepted his present position. Dr. Pino has been a member of the Board on Agriculture since 1983 and previously from 1973 to 1977.

HUGH POPENOE is professor of soils, agronomy, botany, and geography, and director of the Center for Tropical Agriculture and International Programs (Agriculture) at the University of Florida. He received his B.S. from the University of California at Davis in 1951 and his Ph.D. in soils from the University of Florida in 1960. His principal research interest has been in the area of tropical agriculture and land use. His early work on shifting cultivation is one of the major contributions to this system. He has traveled and worked in most of the countries in the tropical areas of Latin America, Asia, and Africa. His current interests include improving indigenous agricultural systems of small landholders, particularly with the integration of livestock and crops. He was chairman of the Advisory Committee on Technology Innovation and a member of the Board on Science and Technology for International Development (under whose aegis this report is presented). He chaired the BOSTID report panels on water buffalo and little-known Asian animals. Currently, he is on the International Advisory Committee of the National Science Foundation and serves as U.S. Board Member for the International Foundation of Science.

MICHAEL HILL ROBINSON, director of the Smithsonian Institution's National Zoological Park, is an animal behaviorist and a tropical biologist. Before his appointment to the National Zoo, Dr. Robinson served as deputy director of the Smithsonian Tropical Research Institute in Panama, which he joined in 1966 as a tropical biologist. He received his Ph.D. from Oxford University after being awarded his B.S., summa cum laude, from the University of Wales. His scientific interests include predator-prey interactions, evolution of adaptations, tropical

biology, courtship and mating behavior, phenology of arthropods, and freshwater biology. In the course of his studies, Dr. Robinson has done research in the United States and throughout the developing world. Recent publications include articles on predator-prey interactions, tropical forest conservation, reproductive behavior in spiders, and the function and purpose of zoos in relation to education and conservation. Dr. Robinson's favorite animals are cats, of all kinds.

KNUT SCHMIDT-NIELSON, J.B. Duke Professor of Physiology in the Department of Zoology at Duke University, has studied animal responses to extreme environmental conditions. His major emphasis has been on life in hot deserts, and he is widely recognized for his studies of camels and other desert animals. His research has involved field studies in North and South America, Africa, Asia, and Australia. Dr. Schmidt-Nielson has written several books, which have been translated into more than a dozen languages, and he has published several hundred research papers. He has been elected to the National Academy of Sciences, the Royal Society, the French Academie des Sciences, and several other academies.

ALBERT E. SOLLOD, is associate professor and head of the international veterinary medicine section at Tufts University School of Veterinary Medicine. He is currently stationed in Niger as chief of party of the integrated livestock project and policy advisor in the Ministry of Animal Resources. He has consulted in 15 countries in Africa and Asia, and his research interests include interdisciplinary systems analysis, indigenous pastoral technologies, monitoring change in agricultural production systems, and monitoring and assessing drought impact.

LEE M. TALBOT received his Ph.D. in geography and ecology from the University of California at Berkeley in 1963 and has worked on environmental and natural resource ecology and management in over 110 countries. At present he is visiting

fellow at the World Resources Institute, Washington, D.C., and senior environmental consultant to the World Bank. He carried out pioneering research in Africa and elsewhere on the use of wild animals for food production. He has written more than 180 scientific and technical publications, including ten books and monographs.

CLAIR E. TERRILL, animal scientist, collaborator, Agricultural Research Service, United States Department of Agriculture (USDA), Beltsville, Maryland, received his Ph.D. from the University of Missouri in 1936, served briefly at the Georgia Agricultural Experiment Station, and joined the USDA at the U.S. Sheep Experiment Station, Dubois, Idaho, in the same year. His research concerned genetics and reproduction of sheep, leading to national and international responsibility regarding research and production of sheep, goats, and other animals, with primary emphasis on increasing efficiency of production of meat, wool, and other products.

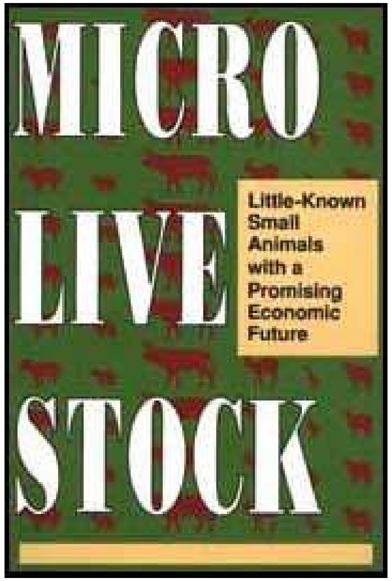
CHRISTIAN M. WEMMER is assistant director for conservation and captive breeding programs at the National Zoological Park and is also in charge of the zoo's 3,100 acre Conservation and Research Center in Front Royal, Virginia. He is vice chairman of the IUCN Deer Specialist Group and a member of the Mustelid and Viverrid Specialist Group of the same organization. His interest in evolutionary and conservation biology has been motivated by frequent travel to South Asia and his role as scientific coordinator of the Smithsonian Nepal Terai Ecology Project. For the past 12 years he has coordinated the development of facilities and programs at the Conservation and Research Center and with Dr. R. Rudran has promoted conservation training and wildlife research in developing nations. He has published over 50 papers on various aspects of mammalian biology and conservation and has co-edited with Benjamin Beck one book on PFre David's

deer. His edited volume "The Biology and Management of the Cervidae" was published by the Smithsonian Institution Press.

DANNY C. WHARTON is associate curator, Animal Departments, at New York Zoological Park, Bronx, New York. He received a B.S. from the College of Idaho and an M.Sc. in 1975 from the School for International Training in Brattleboro, Vermont. His Ph.D. in biology was earned at Fordham University. Dr. Wharton was a Peace Corps volunteer to Ecuador 1969-71 and a Fulbright scholar to Germany 1976-77. His research interests have been in the genetic and demographic management of small populations. He works on several committees including the IUCN/SSC Captive Breeding Specialist Group, Species Survival Plan Committee of the American Association of Zoological Parks and Aquariums, and is species chairman for the North American Propagation Group for the Snow Leopard.

CHARLES A. WOODS IS curator of mammals at the Florida State Museum and a professor of zoology at the University of Florida. He received his B.S. in zoology from the University of Denver and his Ph.D. in zoology from the University of Massachusetts. He worked at the University of Vermont from 1970 to 1979 when he assumed his present position at the University of Florida. His principle research interests have been in the areas of mammalian ecology (Rodentia) and systematics and evolution and he is especially concerned with island biology. He has spent many years working in the West Indies on a variety of projects and has worked closely with the government of Haiti in establishing a plan for the National Parks of Haiti and in completing a biogeophysical inventory of the natural resources of Hispaniola. He is the ecological consultant for the Institut de Sauvegarde du Patrimoine National in Haiti. He is the author of a number of scientific articles on the fauna of the Antilles including a multivolume series on the fauna of the mountains of Haiti.

THOMAS M. YUILL is associate dean for research and graduate training of the School of Veterinary Medicine, assistant director of the Agricultural Experiment Station, and professor of pathobiology and of veterinary science at the University of Wisconsin-Madison. He received his B.S. in wildlife management from Utah State University in 1959 and his Ph.D. jointly in veterinary science and wildlife ecology in 1964 from the University of Wisconsin. His principal research interests are animal health and diseases of wildlife, including those transmissible to domestic animals and to man. He worked in Thailand for two years and has had active research programs in Colombia for 17 years, and Costa Rica for 5 years. He has recently become involved in animal health and production development in the Gambia, West Africa. Dr. Yuill is an executive committee member and immediate past president of the Organization for Tropical Studies and currently serves as president of the Wildlife Disease Association. He completed a five-year term as Chairman of the U.S. Virus Diseases Panel of the U.S.-Japan Cooperative Biomedical Sciences Program.



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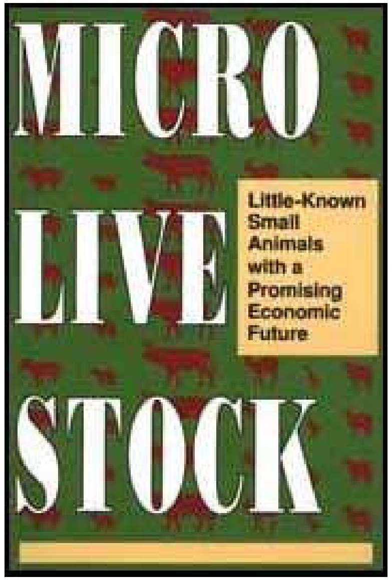

Preface

The purpose of this report is to raise awareness of the potential of small livestock species and to stimulate their introduction into animal research and economic development programs. It is geared particularly towards benefiting developing nations.

"Microlivestock" is a term we have coined for species that are inherently small, such as rabbits and poultry, as well as for breeds of cattle, sheep, goats, and pigs that are less than about half the size of the most common breeds. These miniature animals are seldom considered in the broad picture of livestock development, but they seem to have a promising future. Wherever land is scarce it seems reasonable to assume that, things being equal, small animals would be more attractive than large ones. And land for livestock is becoming increasingly scarce.

In this report we have emphasized multipurpose species with promise for small holders. In some species, the promise is immediate; in others, it is long term, and much research must be undertaken before that promise can be realized or even understood.

We have included wild species that seem to have potential as future livestock. Some are threatened with extinction but are described here because their economic merits may be the key to acquiring support for their protection. Also we have highlighted rare breeds of domesticated species because the current tendency has been to concentrate on a small number of large breeds, and many potentially valuable breeds are becoming extinct through neglect.

The book was prepared after an intensive survey of more than 300 animal scientists in 80 countries. They suggested more than 150 species for inclusion.

The staff then drafted chapters on about 40 species and these drafts were reviewed by more than 400 researchers worldwide. The thousands of resulting comments, corrections, and additions were integrated into the drafts. The panel then met to review the product, to select the most promising species, and to rework the chapters based on their own experiences and joint conclusions. The result is the current 35 chapters. Most of the case studies and accounts of innovations highlighted in the various sidebars were developed by the staff study director.

Collectively, this study covers many species, but it by no means exhausts all the microlivestock possibilities. Lack of space and time precludes discussion of creatures such as edible insects, snails, worms, turtles, and bats, which in some regions are highly regarded foods. Similarly, we have not included aquatic life. These decisions were arbitrary; perhaps invertebrates and aquatic species can be included in future volumes.

This report is addressed to government administrators, technical assistance personnel, and researchers in agriculture, nutrition, and related disciplines who are concerned with helping developing countries achieve a more efficient and balanced exploitation of their biological resources. Hence, we deal with the animals in a general way and do not cover details of biology, husbandry, or economics. A selection of readings that contains such technical information is cited in Appendix A.

A further goal of this project has been to explore the common ground between the disparate arms of animal science: to show that specialists in wildlife, zoology, and livestock science have much to learn from one another's field of expertise; to

show that "fanciers" of pigeons, pheasants, chinchillas, iguanas, and other species may have much to offer livestock breeders - including germplasm; and that those who raise "obsolete" breeds are not only playing a vital role in the protection of rare genes but can offer the benefit of their experience to commercial livestock producers.

Throughout this report, the scientific names of mammals follow those in: Mammal Species of the World: A Taxonomic and Geographic Reference. 1982. J.H. Honacki, K.E. Kinman, and J.W. Koeppl, editors. Published by Allen Press, Inc.; and the Association of Systematics Collections, Lawrence, Kansas, USA. All dollar figures are in U.S. dollars; all ton figures are in metric tons.

This report has been produced under the auspices of the Advisory Committee on Technology Innovation (ACTI) of the Board on Science and Technology for International Development, National Research Council. ACTI was mandated to assess innovative scientific and technological advances, with particular emphasis on those appropriate for developing countries. In this spirit, therefore, the current report includes some extremely unusual species. Whether these will eventually prove practical for widespread use is uncertain, but we present them here for researchers and others who look forward to challenges and enjoy the satisfaction of successful pioneering. The domestication of new poultry, as well as the management of rodents, iguanas, and small deer and antelope, should be viewed in this spirit.

Current titles in the ACTI series on managing tropical animal resources are:

· The Water Buffalo: New Prospects for an Underutilized Animal

- **Little-Known Asian Animals with a Promising Economic Future**
- **Crocodiles as a Resource for the Tropics**
- **Butterfly Farming in Papua New Guinea.**

The production of these books has been supported largely by the Office of the Science Advisor of the U.S. Agency for International Development (AID), which also made this report possible.

WARNING

If misunderstood, this book is potentially dangerous. Because of the severity of the food crisis, the panel has selected some animals - mainly in the rodent section - that are highly adaptable and grow quickly. These seem appropriate for raising only in areas where they already exist, which are clearly identified in those chapters. Such potentially invasive animals should not be introduced to other environments because they could become serious pests. In any trials, local species should always be given priority.

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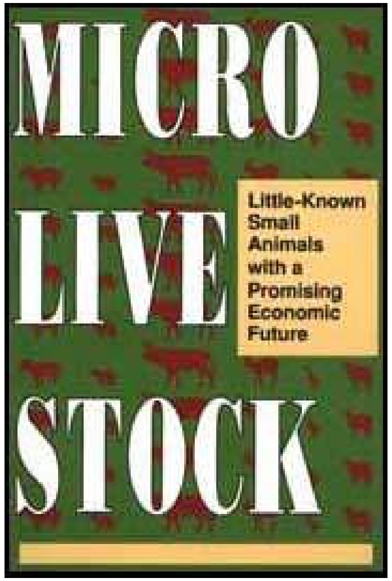
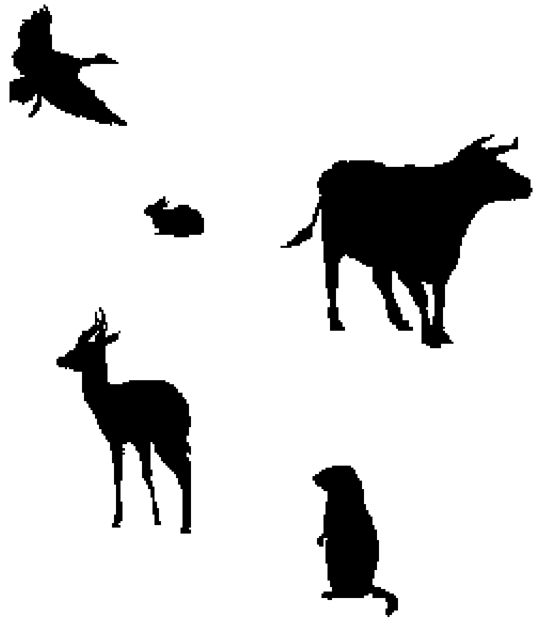
National Research Council. 1991. Microlivestock: Little-Known Small Animals with a Promising Economic Future. National Academy Press, Washington, D.C.
Cover Design by David Bennett
In the developing countries, there are over 100 million farms of less than five hectares, supporting about 700 million people, who represent about 17 percent of the world population. Even more significant is the fact that about 50 million farms

have less than one hectare of land. C. Devendra and Marcia Burns Goat Production in the Tropics We may now be in the wind down stage of bigger is better animal selection trend and it has certainly been a wild ride.... the lesson now being learned is that the bigger breeding animals . . . cost more to maintain, are often slower to reproduce, and may even have a shorter lifespan.
Kelly Klober
Small Farmer's Journal



Introduction



FIGURE

Like computers, livestock for use in developing countries should be getting smaller and becoming more "personal." Conventional "mainframes," such as cattle, are too large for the world's poorest people; they require too much space and expense. "Miniframes," such as the conventional breeds of sheep and goats, have an increasingly important role to play. But tiny, "user-friendly" species for home use are the ones highlighted in this report. We have called them "microlivestock."'

There are two types of microlivestock. One consists of extremely small forms of conventional livestock - such as cattle, sheep, goats, and pigs. The other consists of species that are inherently small- poultry, rabbits, and rodents, for instance.

Microlivestock are important because the developing world's animal production is only a fraction of what it should be. Throughout Latin America, Asia, and Africa, the poor eat almost no meat, milk, or eggs - the most nutritious foods. It is estimated, for example, that in Mexico 25 million campesinos cannot afford meat. In poor countries, even the middle class eats less meat in a year than the populations of North America and Europe eat in a month. Malnutrition is common and its effects, especially on children, can be debilitating. It is one of mankind's most serious imbalances - and most pressing problems.

Rural families in the Third World usually subsist mainly on the products from their homes or farms. Thus, if we are to help their livestock production, more attention must be given to animals that are sized for their situations. Examples discussed in the report are summarized here.

Microbreeds Small breeds of cattle, sheep, goats, and pigs are common in the developing world. Because they are often raised for subsistence rather than for commerce, the national and global contribution that they make is often overlooked. These small, hardy animals deserve much greater recognition.

Later chapters highlight dozens of promising microbreeds. All are less than half average size; some are far smaller than that. The "miniBrahman" cow of Mexico is only 60 cm tall and weighs 140 kg; the southern Sudan dwarf sheep of eastern Africa can weigh as little as 11 kg; the Terai goat of Nepal weighs less than 12 kg; and the cuing pig of Mexico weighs merely 10 kg.

Poultry The widespread use of poultry in Third World villages demonstrates the importance of small, easily managed, household livestock. Small size, the ability to

forage for themselves, and a natural desire to stay around the house put chickens, ducks, guinea fowl, and other birds among the most vital resources of rural Asia, Africa, and Latin America. Scratching a living out of the dirt, dust, ditches, and debris, these often-scrawny creatures are a resource to be taken seriously. For the most poverty stricken, a bony bird may be the only source of meat during much of a lifetime.

Among poultry, there are many underrated, but highly promising, species, including:

- Pigeon. These birds forage widely but return home, thereby providing the farmers with squab, one of the tastiest of all meats.

- Quail. Small and efficient, they, too, are suited to home rearing, and in Japan and a few other countries, large numbers are raised commercially in very small space.

- Muscovy. A native of South American rainforests, this bird is a major poultry resource of France, Taiwan, and a few other countries. Tame, tolerant, and tough, it deserves greater recognition everywhere.

- Guinea Fowl. One of the most self-reliant of all domestic birds, this native of Africa is raised in huge numbers in Europe - notably France. Its potential for increased production elsewhere is exceptional.

- Turkey. The traditional turkey of Mexico still exists as a scavenger bird in villages and household backyards. Unlike the highly selected modern breeds, it is self-reliant, robust, and disease-resistant.

Rabbits Like chickens, rabbits exemplify the vast possibilities that microlivestock offer for increasing meat production in the most poverty-stricken parts of the world. Captive rabbits have been popular as food at least since the time of the Romans. Rabbit rearing has been well established in Europe and China, and now national rabbit projects have begun in many developing nations.

Rodents Some 7,000 years ago, guinea pigs were domesticated as a source of food for the high Andes; even today in the uplands of Bolivia, Peru, and Ecuador, most Indians raise them inside their homes and regard them as an essential part of life. For many Indians, these indoor livestock are the main source of meat. Prolific, tractable, and easy to feed, house, and handle, guinea pigs are even kept in downtown apartment buildings - often in boxes under the bed.

Other rodents might also be suited to domestication; for instance, the potentially tamable, clean-living species of South American fields and woodlands - agouti, capybara, hutia, mare, coypu, pace, and vizcacha. Two remarkable domestication programs have been started in Africa: the grasscutter in West Africa and the giant rat in Nigeria. Both animals provide popular "bushmeat" and researchers are now learning to raise them in captivity. (Because of its tangy taste, Ghanaians actually pay three times more for grasscutter meat than for beef!)

Antelope Another wild African mammal with potential for "household animal husbandry," the blue duiker, is a rabbit-sized antelope. In some areas of Central and Southern Africa the demand is so great that its population is declining at an alarming rate. Duiker rearing, if it can be made successful, might provide both food and an economic alternative to slaughtering the wild populations. It is reported that duikers are easy to maintain and they reproduce well in captivity.

The meat of several other tiny antelope species is also much sought in many African countries, and these animals are also suitably sized to feed the average family at one meal.

Deer Several species of tiny deer - smaller than many dogs - might make useful microlivestock, although much research is needed before their true potential can be judged. Normal-sized deer were once considered too easily frightened to be reared as domestic livestock, but several species are now raised on thousands of deer farms in New Zealand as well as in at least a dozen other countries.

Mouse deer and musk deer (which, strictly speaking, are not true deer at all) are of microlivestock size and are also possible future livestock. The musk deer produces one of the most valuable materials in the animal kingdom - more valuable, in fact, than gold. The musk from the male's glands is used in oriental medicines as well as in European perfumes.

Iguanas Over much of the Caribbean and Latin America, iguanas are a traditional source of food. Indeed, the meat of these large herbivorous lizards is so delicious they are being hunted to extinction throughout their wide range. Their eggs are much enjoyed also. Programs in Panama, Costa Rica, El Salvador, Curacao, and Argentina have developed simple methods to hatch and rear three iguana species.

Bees Honey bees are present almost everywhere, and honey and wax are high-value products that demand little processing and can be stored and transported easily. Innovations in equipment and technique have made beekeeping successful in the tropics without requiring sophisticated hives or elaborate training. Raising bees can also benefit the many crops that require pollination.

THE MICROLIVESTOCK ADVANTAGES

Although animal science has traditionally emphasized bigness, smallness has its advantages. Some of these are summarized below.

Economic

Microlivestock lend themselves to economic niches that are not easily filled by large livestock. Much of their potential is for subsistence production. They are promising for the many peasants who, being outside the cash economy, are now unable to purchase meat, milk, cheese, or eggs. These people can afford only animals that can be raised within the home or backyard under ambient climatic conditions and on feeds that are cheap and easily available.

A subsistence farmer is likely to benefit more from small species than from large because of several factors:

- The animals are less expensive to buy.

- They are less of a financial risk to maintain. (A farmer with several small animals is less vulnerable to loss than a farmer with a single large animal, a feature that is particularly important in subsistence farming where success determines whether the family will survive.)

- They give a faster return on investment. (Small size generally signifies high reproductive capacity and a fast turnover.)

- They provide flexibility. (Farmers can more easily change the size of their herd

or flock to match the amount of feed available at a given time. Also, they can sell animals according to the family's fluctuating needs for cash or food.)

- They provide a steadier source of income.

- They increase the chances of successful breeding because greater numbers are usually kept. (This also means that breeding stock is more likely to be retained in times of scarcity.)

- They are more easily transported. (Who hasn't traveled in a Third World bus or train without chickens, ducks, or guinea pigs as fellow passengers?)

- In some cases they are more efficient converters of food energy.

There are also a number of other benefits to small species.

- Reduced Spoilage. A portion of meat that comes in a "package" of a size that can be readily consumed by a family is important in areas where refrigeration is unavailable or uneconomic. A family can eat the meat produced by most microlivestock in one meal or in one day to minimize the risk of spoilage.

- Efficient Use of Space. The space required for handling and feeding microlivestock is proportionately less than that required for large animals. Low space requirements make many microlivestock (such as guinea pigs, rabbits, pigeons, and quail) available to landless rural inhabitants who have no room for a cow. This is particularly important with respect to feed production.

- Cheaper Facilities. Facilities and equipment required for microlivestock are, by

and large, smaller and simpler than those required for large animals. They often can be made from local products or scrap material or both.

- Ease of Management. Farmers and villagers can manage small animals more easily than large, which is an advantage in the many places where women and children are the main keepers of livestock.

- Increased Productivity. Small animals tend to fit well into existing farming systems, thereby expanding the resource base and recycling nutrients. Some - for example bees, ducks, and geese - can feed themselves by scavenging.

- By-Products. Many species have fur, feathers, skins, and other by-products that are often more valuable than their meat, milk, or eggs. Examples include the feet and tails of rabbits, musk from musk deer, and pelts from rodents such as coypu. Processing such byproducts creates diversification for the farmer and perhaps jobs for the village.

RATIONALE FOR LIVESTOCK PRODUCTION

Many have argued that livestock raising should be discouraged, that it is a primary cause of desertification through overgrazing and that it is an inefficient converter of basic material and energy into human food. "Grow more pulses, grow more grains," these people cry. Their arguments can be valid where the land has high potential for permanent cultivation. Much of the world's surface, however, does not fit into that category, and it is in these areas and for those people who have no access to arable lands that a convincing case for livestock can most easily tee mace. As W.J.A. Payne has written:*

- Livestock, particularly ruminants, can process forage and waste crop materials inedible by man into nutritionally desirable food products, many of high protein, mineral and vitamin content and including some of high caloric value.

- Approximately 40 percent of total land available in developing countries can be used only for some form of forage production and a further 30 percent is classified as forest with some potential for the production of forage. Some 12 percent of the world's total population live in areas where people depend almost entirely on the products obtained from ruminant livestock.

- Livestock provide a range of extremely valuable by-products. Dung is not only a fertilizer and soil-stabilizer but also a fuel of often considerably greater value than the fodder consumed in its production. Other byproducts, especially hides and wool form the bases of rural enterprises that may provide significant incomes to the poorest members of society.

- Animal plant and human life are ecologically interdependent. The establishment of agricultural systems in which livestock are integrated with crops, forestry and aquaculture is essential for the improvement of overall productivity.

Livestock produce food that adds to the nutritional quality and variety of human diets. Although it is possible for humans to exist without them, these foods are relished and sought after by the majority of humanity. These foods include meat, eggs and processed products such as biltong and cheese.

Feed

In general, small species tend to expand the food base by using a wider array of

resources than do major livestock such as cattle. Many can be raised on feeds that people discard: fibrous residues, industry by-products, or kitchen wastes. Some collect minute feeds that otherwise go unused. For example, chickens and pigeons gather scattered seeds, turkeys gobble up insects, geese graze water weeds, iguanas feed in the tops of trees, and bees collect nectar and pollen from flowers that may be miles away.

Even some grazing microlivestock prefer different forages from those preferred by cattle. Antelope and deer, for instance, browse tree leaves; capybara and grasscutters eat reeds. Combining microlivestock with conventional livestock results in a more complete utilization of forage resources and greater animal production per hectare.

Under conditions of abundance, small size may be of no advantage in mammals, but if feed is limited, it is of great help. A small animal (or its keeper) needs to cover less area to fulfill its daily requirements, so that microlivestock may grow fat in areas where the forage is too sparse to support a larger animal. This is particularly vital when there are seasonal bottlenecks. For example, feed may be plentiful enough for most of the year to supply many large animals; however, the dry season may greatly restrict the numbers that can be kept.

Although small animals generally require proportionately higher inputs of feed, they also grow proportionately faster (see sidebar opposite). In addition, species such as rabbits, guinea pigs, and grasscutters digest fibrous matter with surprising efficiency, even though they are not true ruminants like cattle, sheep, and goats.

Reproduction

Many small animals have high reproductive capacity with short gestation periods, large numbers of offspring, and rapid juvenile growth. They tend to reach sexual maturity at a younger age than large animals, and the interval between the generations can be very short. Thus, meat or other products can be produced more rapidly and more evenly throughout the year.

Cows, for example, produce a maximum of one calf per year. A pig, on the other hand, may produce 7 or more young; a rabbit, 30 or more; a chicken, more than 100.

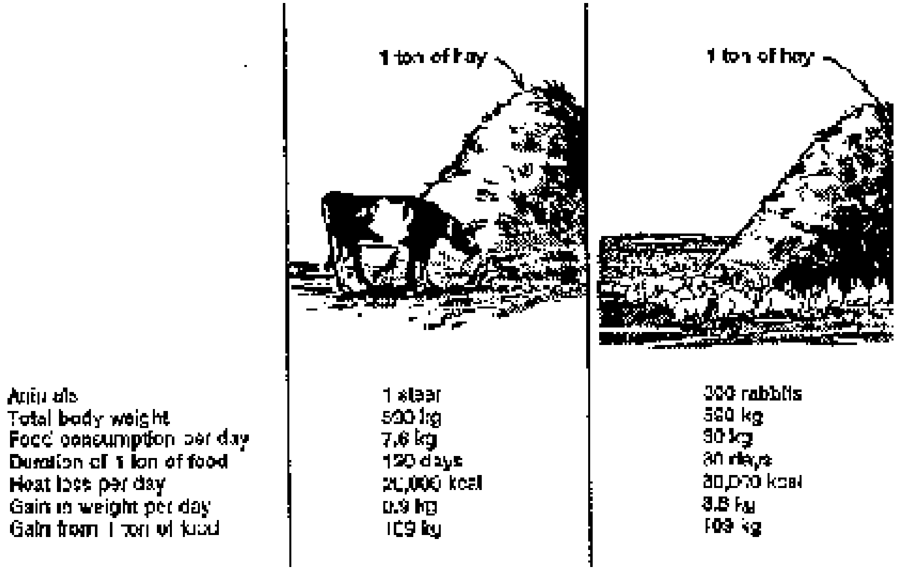
Adaptability and Hardiness

The survival rates and manageability of many small breeds and species can be outstanding. Smallness is often an adaptation to harsh environment. Indeed, a major promise for microlivestock is in special environmental niches. Where cold, heat, temperature fluctuations, aridity, or humidity are extreme, microlivestock are likely to show their greatest advantage. Chickens, guinea fowl, goats, and many other small species already live in villages, homes, and backyards in harsh and disease-prone climates, and are usually given no care and sometimes no food: they have to scavenge for their sustenance and survive as best they can. Such selection pressures result in animals of remarkable adaptability, tolerance, and robustness.

Some microlivestock can produce under conditions where conventional species die. The capybara, for instance, is at home in the Latin American lowlands, where

the climate is hot and humid and floods cause seasonal inundations. Cattle, by contrast, die because of malnutrition, foot rot, or drowning. Other microlivestock species with a wide tolerance to ecological extremes include the turkey, pigeon, and bee. And some dwarf breeds of cattle, sheep, goats, and pigs show surprising tolerance to trypanosomes, the parasites that make conventional breeds impossible to maintain throughout much of Africa.

Some small species can be raised in cities, where poverty and malnutrition are often worse than in rural areas. It is estimated, for instance, that one million livestock exist in Cairo, not counting the pigeons that are raised on countless rooftops. Goats and cattle are common in urban India, and many Third World cities have far more chickens than people.



Food utilization versus body size

MICROLIVESTOCK LIMITATIONS

Raising microlivestock is not a panacea for the Third World's food problems. Efforts to develop them will not be without difficulties. Some likely problems are noted here.

High Energy Requirements

Smaller animals tend to have a higher feed requirement per unit of body weight than large animals. Anatomical and physiological constraints prevent them from meeting their relatively high energy requirements simply by increasing the rate of food ingestion. Therefore, for optimum production, some small animals, particularly nonruminants, require feed that is higher in protein and lower in fiber than large animals. This is particularly true when the small animals are compared with ruminants such as cattle, sheep, and goats.

Increased Labor Requirements

The advantages of low investment, fast return on capital, flexibility, and efficient resource utilization are offset by higher demands for labor. Keeping small animals often requires considerable effort, and its economic viability may depend on the availability of cheap and willing labor. Many small animals are raised at home by family members, such as children, the elderly, and the handicapped, who have time available and whose labor costs are nominally zero.

Diseases

Some potential microlivestock are undomesticated, and resistance to diseases and parasites is one justification for their consideration. However, the general healthiness of a species when it is free-ranging can be a misleading guide for its

husbandry. Confining any animal in high density invariably increases the potential for the spread of infectious diseases and parasites. Moreover, mismanagement can foster respiratory and gastrointestinal diseases (such as salmonella or coccidiosis) that are rare among scattered populations.

Some microlivestock are potential reservoirs for diseases that affect not only local animals but people as well. This may limit their successful development in some areas. Although the dangers are often exaggerated, controls may be needed, particularly of rinderpest, tickborne diseases, and those diseases communicable to humans.

Predation

Small size makes microlivestock easy prey.

Lack of Research

Techniques to manage some microlivestock species are not yet well established. The development of appropriate husbandry techniques, as well as a better understanding of the animals' particular biological and behavioral characteristics, will be needed before major progress can be made. These species (for instance rodents, deer, and iguanas) may require collection of different genotypes, as well as studies of diseases, nutrition, and management.

Complex Logistics

It is complicated and expensive to reach millions of widely scattered peasants, each having only a handful of small animals. Even though total production may far exceed that of commercial farms raising large animals, the smallholdings are often dispersed, their animals are often used for subsistence rather than commerce, and their managers are often ill-trained and illiterate.

Legislative Restrictions

The use of some microlivestock species may be restricted by legislation. For instance, some countries have meat and veterinary laws that work against the development of species other than cattle. Others have laws to protect wildlife, which could be important in the case of species such as antelope, deer, pace, and iguana.

Lack of Markets

Microlivestock need not be just for home or local consumption; they can also be raised for market. But some commercial programs, including some with rabbits and guinea pigs, have failed because no public demand was developed.

Resistance to New Species

People have close associations with livestock, and in most cultures they do not easily accept animals or animal foods that are radically different from their traditional ones. In general, the ties between certain ethnic groups and a particular species or breed is very strong (one reason, for example, why European colonists introduced their own large breeds of cattle and sheep to Africa and Asia, paying little attention to small indigenous breeds). Moreover, people who are used to bringing the animal to the feed rather than the feed to the animal may resist a small animal that has to be penned up and fed by hand.

Opposition to Smallness

Finally, there seems to be an innate human trait that considers bigger to be better, especially among the common livestock. For example, because many tropical cattle are small, there is strong inclination on the part of those responsible for livestock improvement to dismiss them or to increase their size by crossing them with large breeds.

FUTURE OF MICROLIVESTOCK

Small animals are likely to become increasingly important. As human populations increase, the space available for growing forage decreases, and this phenomenon favors small animals. Many villagers already have little or no pastureland. Some live in areas (the rice-growing areas of Southeast Asia, for instance) where crops are grown on almost every square meter almost every month of the year. Microlivestock are potentially important for urban areas of developing countries as well. There, too, land is at a premium and is usually inadequate for raising conventional livestock.

So far, however, microlivestock have been largely ignored. Compared with cattle, they have been accorded little scientific effort. In the drive towards larger animals, stimulated by experience in the temperate zone, the virtually unstudied gene pool of small species and breeds has been mostly bypassed. There have been few attempts to assess or improve their farm productivity.

This is unfortunate, and it is perhaps due to the fact that small animals may be less efficient at digesting certain foods and therefore technically less attractive

than large, "modern" breeds. But to Third World peasants, an animal's efficiency is far less important than its survivability and manageability. If an animal cannot be raised under village conditions, its feed-use efficiency or milk yield is irrelevant.

Microlivestock production should be integrated into most ruraldevelopment projects. Small animals offer a way to improve the lives of people who are hard to reach by other methods. Only by expanding research on the husbandry, hygiene, nutrition, reproduction, physiology, and breeding can the promise of animals sized for small farms and villages be fulfilled. Moreover, the costs will be small compared with those of programs for large animals.2

Specifically, experiment stations should produce and promote methods and materials for use in rearing microlivestock. Donors and development institutions, planners, and policymakers should note the potentials of microlivestock and the benefits that can be derived from them. Teaching manuals and materials are needed, and classes in microlivestock husbandry should be included in rural school curricula.

Raising personal livestock on weeds and table scraps in cages beside the house or boxes under the bed will, in many instances, get quality protein to the most poverty stricken more effectively than raising large livestock on pastures.

Although small size confers many advantages, the question is not whether the large or small animal is "best," but rather how well each can meet a person's varying requirements. In a given situation, livestock can be too small or too large. But the fact remains that not everyone who wants meat or money has the resources to acquire, keep, manage, or utilize a large animal.

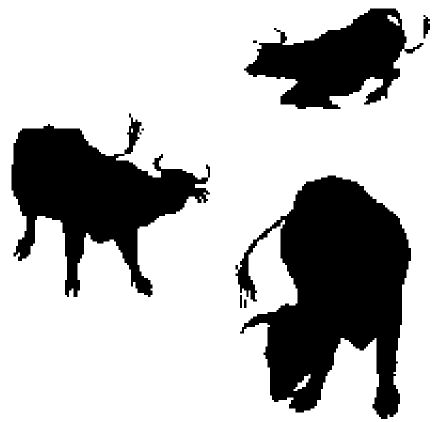
The key is balance. Both microlivestock and traditional livestock deserve serious attention. Indeed, it seems likely that the two will seldom compete. Most microlivestock complement traditional livestock because of unique physical, physiological, behavioral, or economic characteristics. They increase the range of options for the millions of poor for whom the choice may not even be between large and small livestock, but between microlivestock and no livestock at all.

It's an unfortunate fact that small animals don't have the prestige among Third World farmers that large animals do (perhaps this arose because children can look after goats and sheep but it takes men to look after cattle). Even sheep and goats are not accorded the same stature as cattle.

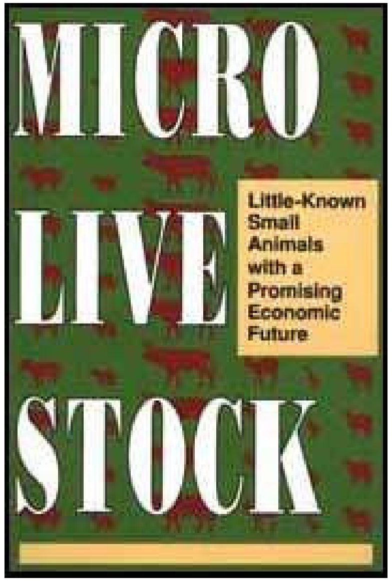
Hugh Popenoe

Breeds and varieties were created from mutant genes and thus haste become living reservoirs of these genes, holding them for use in future generations of mankind.

Anonymous



FIGURE



Micro-livestock: Little-known Small Animals with a Promising Economic Future (BOSTID, 1991, 435 p.)

Part I : Microbreeds

FIGURE

Cattle, goats, sheep, and pigs supply millions of people around the world with the bulk of their cash and animal products. Yet scores of breeds - especially in the tropics - are left out of livestock development projects merely because they are considered too small. These "microbreeds"' have sometimes been considered genetic dead ends because they appear undersized and puny. Many of these traditional animals - some in local use for thousands of years - are disappearing, and even the small ancestors of large modern breeds are becoming extinct.

These small breeds deserve to be studied and developed in their own right. Throughout Africa, Asia, and Latin America, these usually hardy animals are especially adapted to traditional husbandry practices and harsh local conditions. Some have remarkable qualities and are well adapted to resist hostile weather, ravaging pestilence, and poor diets. In remote places and in areas of extreme climate, they are often vitally important for basic subsistence.

Indeed, because of stress or disease, or insufficient forage, land, or money, microbreeds may be the only practical livestock in many settings. Their individual output may be low, but it can be efficient considering the lack of care and poor feeds they are given. Their availability and the growing number of small-sized farms in the developing world make them increasingly worthy of consideration.

The following chapters in this section describe microcattle, microgoats, microsheep, and micropigs.

1 Microcattle

FIGURE

For the purposes of this report, "microcattle" are considered to be small breeds of cattle (Bos taurus and Bos indicus) with a mature weight of about 300 kg or less. In many areas of the developing world, these are actually the animals most widely held by farmers and pastoralists. They are often treasured because of their resilience and simple requirements. Many survive and produce under harsh conditions, grow rapidly, calve easily, show good maternal ability, yield lean meat, or have other advantages.

Microcattle have generally been ignored in the push towards larger animals, but they seem inherently suitable for traditional and small-farm husbandry. As rural people in developing countries improve their own productivity, as they become more aware of nutritional needs, and as they depend more upon cash economies, microcattle could become vital means for improving personal, dietary, and economic status.

AREA OF POTENTIAL USE

Worldwide.

APPEARANCE AND SIZE

Cattle have been classified in many ways, but they are generally designated as humped or humpless types. However, clear distinctions among them are sometimes difficult or impossible to make because they have intermingled for thousands of years. Representative microcattle types are listed at the end of the chapter.

DISTRIBUTION

More than two-thirds of the world's 1.3 billion cattle are found in the developing world; one-third is in the tropics. As noted, a considerable number of these could be called "microcattle."

STATUS

Many strains of microcattle are threatened with extinction because of replacement or crossbreeding with larger types. This is in some respects shortsighted because promoting just a few breeds contributes to narrowing of the genetic base, and valuable traits may be lost when selection is done to conform to any preconceived standard, including large size.

HABITAT AND ENVIRONMENT

Microcattle are adapted to a wide variety of habitats. Many types thrive - even with little or no attention - in climates that are hot, humid, arid, or beset by diseases and parasites.

BIOLOGY

Cattle are ruminants and digest fiber well, although they are selective foragers and prefer tender grasses and low-growing legumes.

As with other tropical cattle, microbreeds generally reach physical and sexual maturity in 2 or 3 years. Many can breed year-round when conditions are favorable (gestation lasts about 9 months). Cows may remain fertile 10 years or

more, and can live more than 20 years.

BEHAVIOR

Cattle usually graze from as few as four hours to as many as eight hours a day. If feed is of poor quality, they must forage (and ruminate) longer to receive adequate nutrition.

Microcattle are commonly docile and undemanding animals, and many small breeds are surprisingly responsive to humans.

USES

Like conventional breeds, microcattle produce the same well-known products: meat, milk, manure, hides, horn, blood, and bone. They are also used for traction.

Small cattle often produce only modest amounts of milk and meat per animal. However, given higher stocking rates, a herd of microcattle is often able to outyield larger, genetically improved animals on a per hectare basis, especially under stressful conditions. When their ability to survive adversity and poor management is taken into account, they may often be far and away the most efficient cattle for traditional husbandry.

Surprisingly, there is a place even for small draft animals. They tend to be active, thrifty (efficient), and more maneuverable in tight spaces, and so are adapted for use in the small fields, terraces, and paddies that are becoming increasingly common. The small hill cattle of Nepal, for instance, are valued because they can negotiate steep slopes and narrow terraces on Himalayan mountainsides.

HUSBANDRY

Microcattle are handled like their larger counterparts, but herding, tethering, fencing, and hobbling are generally easier.

ADVANTAGES

Cattle are familiar animals that are accepted in nearly all cultures; their meat, milk, manure, and leather are in demand almost everywhere. In many societies, beef is preferred over other meats, even by those who can rarely afford it.

In most areas, organized breeding, production, and marketing associations are already in place. Microcattle can also integrate well into traditional forms of husbandry, whether in pastoral herds of hundreds or as solitary backyard milk cows.

Under humid and hot conditions, microcattle probably suffer less than larger breeds because their greater ratio of skin area to body mass enhances their ability to shed heat.

The number of cattle that can be kept on a given parcel of land may be increased, sometimes even doubled, with smaller animals. Microcattle can also be penned and fed cut-and-carry forage more easily than can larger cattle, and more of them can be maintained on the same amount of feed. This permits more continuous production and less financial hardship when an animal perishes.

Small cattle may require less labor because they are generally easier to handle, herd, confine, and transport. They usually have few problems with calving, and as

a rule require little or no assistance.

Some microcattle have unusual tolerances to disease. In Africa, for instance, there are breeds that tolerate or resist trypanosomiasis, a parasitic disease that makes large areas of that continent uninhabitable for most other cattle breeds. Others seem more tolerant of internal or external parasites, theileriosis (east coast fever), rinderpest, or other afflictions.

LIMITATIONS

Microcattle often lack the prestige of larger breeds.

When given quality forage and supplemental feeding, small unimproved cattle may not match the overall productivity of the large, highly developed breeds. Their greatest potential may prove to be for traditional husbandry and for grazing marginal areas where survival is more important than feed efficiency.

BONSAI BRAHMAN

In Mexico, researchers are deliberately creating microcattle. Since 1970, Juan Manuel Berruecos Villalobos, former director of the Veterinary Medicine school at the National Autonomous University, has directed this enterprise. He and his colleagues have miniaturized cows by selecting the smallest specimens out of a herd of normal-sized Brahman cattle and breeding them with one another. After five generations, adult females average 15-180 kg adult males 20-220 kg. A few of the smallest cows are now only 60 cm tall and 140 kg in weight. Merely one-fifth of normal weight, they are shorter than the turkeys that share the barnyard with them. Indeed, they even get lost in the grassy pastures so that the farmers cannot

see them.

This program seems to have yielded a productive animal that can be cheaply and easily maintained in a small space. Berruecos has demonstrated that the tiny cows can be stocked on one-third the area needed to support one normal-sized cow. He reports that they are giving remarkable amounts of milk: up to four lifers a day, compared with six lifers from their full-sized counterparts. On a feed-intake to weight-gain basis, the tiny cattle are no less efficient than their normal-sized counterparts.

Although 17 years have gone into the selection of what Berruecos calls his "bonsai cattle," the process is not yet finished. Future goals include testing embryo transplants to see if one normal-sized cow can support multiple "microfetuses" (possibly as many as eight). This would help to rapidly increase the numbers of the miniature form, which weigh merely 4-5 kg at birth.

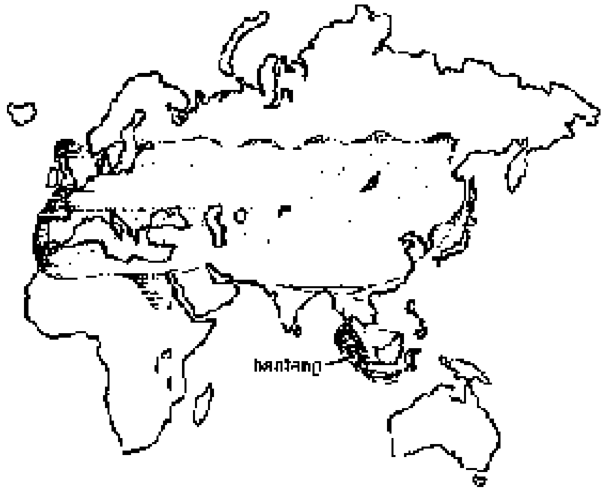
All in all, the Mexican researchers see miniaturization as a new option for governments and farmers increasingly squeezed by shrinking farm land and rising production costs. Small livestock they say, are a way to produce more food on less land faster. For example, a campesino with almost no land can have one or two bonsais, but could never maintain a standard-sized cow.

RESEARCH AND CONSERVATION NEEDS

Their adaptability and robustness make microcattle worthy of preservation, study, and greater use, and they should be incorporated into many ongoing programs.

Selective breeding, although infrequently attempted, can probably improve

productivity significantly. Records of breed history should be established, and unusual or special characteristics noted and the information disseminated.



Original distribution of wild cattle and banteng (Based on Mason , 1984)

In areas where small, indigenous breeds are being replaced, representative populations should be maintained and studied to increase understanding of their adaptive diversity and to retain a genetic storehouse for the future.

REPRESENTATIVE EXAMPLES OF MICROCATTLE

Dwarf West African Shorthorn

West African coastal forests, and inland. Female 125 kg; male 150 kg. Adaptation to harsh, humid climates and good resistance to trypanosomiasis and other diseases allow these small animals to exist where other cattle die. They are perhaps the smallest cattle of all (often weighing less than 100 kg). In the areas

of worst disease and highest rainfall, this hardy animal is often found thriving, but half wild.

Muturu Nigeria. Female 160 kg; male 210 kg. This notable subtype is slightly larger. It is the most trypanotolerant of all cattle, showing no symptoms or loss of vitality. It is widely kept, mostly as a village scavenger and often as a pet, and yields a high percentage of meat.

N'Dama

West Africa. 200-400 kg. These active, stocky animals utilize low-quality forage, produce good beef, and are used as light draft oxen. Milk production, though poor, improves with feeding level. N'Dama mature early and are exceptionally fertile, and they have already become important in breeding programs. They are resistant to trypanosomiasis, and can exist where temperatures average 30° C with 1,500 mm annual rainfall. In the least hospitable areas, N'Damas ranging down to 200 kg are often the only cattle that can remain productive.

Rodope

Southeastern Europe. Female 200 kg; male 350 kg. A humpless multipurpose breed - draft, milk, and beef - that is exceptionally hardy. The milk is high in butterfat. Possibly adaptable to the subtropics. It is rapidly being lost to crossbreeding.

Zebu

Zebus are among the most important tropical domestic animals. However, the

dwarfs are not well known, although in many areas they are preferred, especially as draft animals. Zebus use less water, even though their sweat glands are larger and more numerous than those of most other cattle. All have a low basal metabolism and resist heat well. In general, they also have high resistance to ticks and other parasites.

Taiwan Black Taiwan. Female 250 kg; male 250 kg. Well adapted to poor tropical conditions, these work animals are also used for meat.

Kedah-Kelantan Malaysia. Female 200 kg; male 250 kg. Hardy, well adapted cattle with exceptional fertility on a poor diet, both sexes are used as draft animals as well as sources of meat and cash.

Sinhala (Dwarf Zebu) Sri Lanka. Female 200 kg; male 250 kg. An ancient type of zebu, preferred for its handiness in cultivating small paddies and terraced fields.

Nuba Dwarf Sudan. 180-220 kg. These work animals are well proportioned but are not slaughtered for meat, and milk production is low. Although tolerant to trypanosomiasis, their numbers have dwindled because of crossbreeding.

Small Zebu Somalia. 160-230 kg. These small native cattle are used for beef, milk, and for work. They are well adapted to poor feed in a desolate environment.

Abyssinian Shorthorn Zebu (Showa) Central highlands of Ethiopia. Female 225 kg; male 305 kg. These widespread, small-humped cattle are very hardy. They produce beef and are generally milked, with surplus production about 2-4 kg daily. Resistant to many parasites, they also have a gentle disposition and make good work animals.

Dwarf Zebu (Mongalla) Tanzania, Uganda, and Kenya. Female 150 kg; male 250 kg. A highly variable, long-entrenched, small, East-African zebu with some nonzebu blood. Pastoralists favor it because of its hardiness. Although slow-maturing, it is well-fleshed, can yield excellent beef, and some types are milked.

Mashona Zimbabwe. Female 200 kg; male 250 kg. This hardy zebusanga type (see below) is widespread in drier areas and has a high resistance to disease and parasites. Since the 1940s, it has been bred for beef production and selected animals now weigh more than 500 kg.

Mini-Brahman Mexico. 135 kg. Downsized from 450-kg Brazilian zebus through selective breeding by Mexican researchers, these gentle animals are reported to yield two-thirds as much milk (3-4 liters daily) as the parent stock. Because of much higher stocking rates on grass, production per hectare is reportedly greater than with full-sized animals (see sidebar, page 22).

Criollo

Central and South America. Descendants of Spanish and Portuguese cattle imported over 400 years ago, "criollo" cattle have adapted to a wide range of harsh climates. Many varieties are small: mature females often weigh 200-300 kg or less. They sometimes produce little beef or milk under traditional conditions and management, but they are extremely hardy and survive when other cattle perish. Through importation and crossbreeding, many local types have been lost or are threatened.

Chinampo Baja California, Mexico. 200-350 kg. Extremely tolerant of wild desert

conditions, these docile criollo cattle exist largely on scrub and cactus. They get most of their water from succulent plants, have a low metabolic rate and body temperature, and are mostly active at night.

Florida Scrub Florida, USA. 225-300 kg. Genetically isolated for more than 300 years, the Florida Scrub is very hardy in harsh, subtropical conditions. It has good resistance to ticks and screwworm, and can subsist on forage with a high roughage content.

Sanga

This type - an ancient cross between longhorns or shorthorns and humped animals - is found throughout eastern and southern Africa. It weighs from 150 to 500 kg or more. Some types have been selectively bred or crossed with European cattle and are quite productive.

Bavenda Transvaal, South Africa. 240-290 kg. This hardy and disease tolerant tropical variety is small and prolific. It is generally used for draft, barter, and beef. However, it has been crossbred with larger animals so frequently that the smaller types are almost extinct; most "Bavendas" now weigh more than 300 kg.

Ovambo' Northeastern Namibia. Female 160 kg; male 225 kg. A calm and docile animal with a small hump, it is used by seasonal pastoralists for beef and milk.

Nilotic Sudan. 180-300 kg. These cattle of southern Sudan show great variation in size, partly due to environmental factors. They are generally resistant to local parasites and worms, have good potential for increased beef production, and their milk is very important locally.

Chadian "Native" and Dwarf Black Cattle

Chad. Female 225 kg; male 275 kg. These two types are small, humped meat animals that graze the sparse savanna and are very drought resistant. Little scientific information exists about them.

"Arab Cattle"

Middle East. Small types (female 225 kg; male 300 kg) are used for meat and some milk, especially in Lebanon. There are many local forms with variable appearance, but all have small humps. Well adapted to grazing sparse vegetation on rough land, they are becoming rare due to crossbreeding.

Hill Cattle

Nepal. Female 160 kg; male 200 kg. A widespread type often recrossed with Indian zebu animals, they are bred to be small. They are thrifty creatures that maintain themselves well on poor forage. Bulls make sure-footed draft animals on rough ground and slopes, and the cows are milked.

Tibetan Dwarf

Tibet. Less than 250 kg. These humpless cattle are used as pack animals and can tolerate poor forage and high altitudes.

Yellow Cattle

Southwest and south China. Female 220 kg; male 380 kg. In the subtropics and

tropics, small multipurpose types of Yellow Cattle withstand high temperature and humidity. They are used mainly for work and meat, and seem well adapted to poor feed, harsh conditions, and rugged terrain. The Chowpei (190-380 kg) is a hardy working breed of more temperate areas in Hubei Province.

Cheju Hanwoo

Korea. Female 230 kg; male 280 kg. A yellowish-brown Cheju Island native that has almost no calving difficulty, it is well adapted to poor grazing conditions in harsh environments and is docile and obedient.

Madura

Indonesia. Female 220 kg; male 300 kg. An ancient cross between humped cattle and the banteng (see sidebar), these heat- and disease resistant hybrids also have good grazing and mothering ability, and are kept in the most extreme humid tropical environments. Breeding for fighting and racing has given them a poor disposition.

Dexter Cattle

Ireland and North America. 220-360 kg. This breed can be traced back to eighteenth-century Ireland and is believed to have been developed by peasant farmers living on rough land. It is exceptionally hardy and produces both milk and meat. In North America, it has become popular among city folk who acquire country property, as this microbreed is particularly well suited to their usually tiny farms.

BANTENG: THE CUTEST COW

The banteng (Bos Javanicus) is a small Southeast Asian bovine with a promising future.* It is a different species from cattle. The two will interbreed, but the hybrid offspring are normally sterile.

Although almost entirely neglected by the animal science community, the banteng is remarkable for an ability to thrive under hot, humid, and disease-ridden conditions where cattle often grow poorly. The sexes are easily distinguished: males are jet black, females are golden brown. Both have bright white socks and rumps as if they had been freshly whitewashed.

Wild banteng are found in remote areas of countries from Burma to Indonesia. But only Indonesia has used it as a farm animal so far. It has more than 1.5 million domesticated banteng - some 20 percent of the country's total "cattle" population. Indonesian farmers value the animal's agility, which allows them to cultivate Relds too narrow for cattle to turn the prow. In addition, gourmets consider banteng meat the tastiest of all. Indonesia appreciates the banteng so much that it has established a genetic sanctuary on the island of Bali - banning cattle in order to maintain the banteng's genetic purity.

Outside Indonesia, only a few scientists have studied this animal, but it seems clear that it is particularly useful under tropical conditions. In heat and humidity, it thrives; even when cattle are starving, one rarely sees a skinny banteng. And demand for its meat is never ending.

2 Microgoats

More than 90 percent of the world's nearly half billion goats (Capra hircus) are found in developing countries; many weigh less than 35 kg fully grown.´ Such "microgoats" are noted for their high reproductive rates, rapid growth, early maturity, tasty meat, and rich milk' as well as for their robust constitution, ease of handling, and tolerance of climatic stress and poor feeds.

To many people - especially where pigs and poultry are not common - meat and milk from microgoats are the primary animal proteins consumed during a lifetime. Perhaps the world's best foragers, goats eat practically anything made of cellulose, and are not dependent on grass. Because of their unselective feeding behavior, they are capable of living where the feeds - tree leaves, shrubs, and weeds - are too poor to support other types of livestock.

Such microgoats deserve wider recognition, for they are often the poor person's only source of milk, meat, and cash income. They are cheap to acquire and easy to maintain, even by people with little property and scarce resources.

AREA OF POTENTIAL USE

Worldwide, especially in arid and semiarid climates.

APPEARANCE AND SIZE

Goats generally have a long snout and an upright tail, by which they can be distinguished from most sheep. The mouth is unusual in having a mobile upper lip and a grasping tongue, which permits the animal to nibble even tiny leaves on spiny species.

Common commercial goat breeds generally weigh between 60 and 100 kg, with some weighing more than 200 kg. Microgoats may weigh less than 15 kg. Representative examples are listed at the end of the chapter.

DISTRIBUTION

Worldwide, with half in Asia and one-third in Africa.

STATUS

The FAO projects that world numbers may nearly double by the turn of the century. Goats are thus not endangered, but in some areas select populations of feral goats are being deliberately eradicated, with the consequent loss of potentially valuable genes. Some small breeds are also threatened by excessive crossbreeding with larger types.

HABITAT AND ENVIRONMENT

One of the most adaptable of all livestock, goats can persist in conditions from arid to humid, and from sea level to high altitude. They are especially well adapted to hot, semiarid climates and to rocky, barren terrain.

BIOLOGY

These ruminants can subsist on many feedstuffs that would otherwise be left to waste. Although selective browsers, they often prefer coarse leaves (including palm fronds) and shrubbery to palatable forage grass.

Most microgoats mature quickly, and in the tropics they can generally breed year-round. Their reproductive potential has often been underestimated; kidding is rarely difficult, and many types produce twins and sometimes even triplets or quadruplets.

In hot, dry areas, goats require less attention than other livestock, and smaller goats have the added advantage of better heat dissipation. Some microgoats may also show disease resistance. For example, tolerance to trypanosomiasis makes them an important livestock in many regions of Africa.

BEHAVIOR

Goats are generally gentle, but can be easily frightened. They may become stubborn and aggressive when threatened or thwarted, and can prove hard to confine.

If their feed smells of other animals - particularly of other goats - they usually shun it unless nothing else is available.

USES

Microgoats mainly produce meat and form an important part of the diet in southern Asia, the Middle East, Africa, and Latin America, especially the Caribbean. Goat is sometimes a preferred meat, and there are few social or religious prohibitions against eating it.

Some microgoats are good milkers, and under stressful conditions they may keep producing when other livestock are dry. Goat milk is a valuable dietary

supplement: it is nutritious, easily digestible, and usually commands premium prices. It makes excellent cheese and yogurt and can be used by people allergic to cow's milk.

Microgoats produce some of the finest and most valuable fibers in the world. Angora and Cashmere goats often weigh less than 30 kg fully grown, for example.

Goats produce a fine-textured, durable leather that finds extensive uses both locally and internationally. Horns, hooves, blood, and bone meal also have commercial value. Manure is another important product, and comes in fairly dry pellets that are easy to collect, store, and distribute.

Goats perform important functions in land management. Seeds of many trees (Acacia and Prosopis, for example) are "scarified" by passing through the goats' digestive system, fostering germination and natural revegetation. With care, goats can also be used to clear land of weeds and brush.

HUSBANDRY

Goats are often allowed to roam and scavenge for their own food. They form strong territorial attachments and can be trained to stay within a designated area. However, they cannot be kept from investigating - and quite probably devouring - anything within that territory. They are persistent browsers, so it is essential to prevent overstocking as well as raids on crops.

Variety of diet is important, and goats show much individuality in feed preferences. They are often raised on crop residue and kitchen refuse.

Goats can be run with other livestock without creating serious competition. The goats browse weedy shrubs, whereas the sheep and cattle graze more on grasses.

Although perhaps the hardiest of all livestock, most breeds benefit when they are provided shelter from rain and high-noon sun. Abrupt chilling and poor ventilation can cause severe respiratory problems. They are also susceptible to various maladies, such as internal parasites, especially when confined. The highest mortality, however, is caused when very young kids are not supplied with adequate feed and clean, dry shelter.

ADVANTAGES

In most developing countries goats are already prominent in rural life. Common almost everywhere in Africa, Asia, and Latin America, they are dependable multi-use animals. They are particularly important in providing ready cash, such as for school fees, taxes, marriages, or funerals.

Goats integrate well in mixed agriculture, for example, by consuming leafy wastes, clearing land, and contributing fertilizer. In many places they are raised almost exclusively by women and children. If confined, goats require only simple, inexpensive shelters or pens, which makes them especially important as subsistence animals. In many situations, they may be the most efficient and economic producers for smallholders.

These animals have a relatively fast rate of growth and early reproductive age, even under harsh conditions. They can graze rougher terrain than cattle and most sheep, can go for longer periods without water, and forage well in wooded areas

where grass is lacking. They can derive most or all of their diet from roughage unusable by humans; high-energy feeds, such as protein supplements or carbohydrate supplements, are usually not needed even to fatten them for slaughter.

Goats are generally healthy and are not affected by many of the parasites and diseases that ravage other livestock. Some resistance to mange, internal parasites, foot-and-mouth disease, and other livestock scourges has been reported.

LIMITATIONS

In some places (notably, in industrialized nations) there is a strong prejudice against goats and goat meat.

Smallness makes microgoats targets for predators and thieves.

Many small goats are poor milkers, especially under hardship conditions; however, even small amounts of milk can often fulfill a child's daily nutritional requirement or reinforce a nursing mother's diet.

Goats are independent and may wander away if not watched, and they can be difficult to pen. They may also have an unpleasant odor when kept confined (males are particularly malodorous during rutting season).

Goats are often disparaged for degrading land and destroying vegetation because they continue to survive on overutilized lands often laid waste by mismanagement of sheep or cattle.

FRESH GENES

A rare wild animal with spectacular horns, the bezoar (Capra aegagrus) is the goat's wild ancestor. People domesticated it before 7000 B.C., probably in the mountains along the Iran/ Iraq border. Until recent times, it remained widely scattered across the vast region between Greece and Pakistan, but it now exists only in pockets and is threatened with extinction.

This would be a tragedy because the bezoar is a resilient wild species that crosses readily with domestic goats, and it could pass on its genetic inheritance for heat, drought, and cold tolerance: disease resistance; and other survival qualities.

Distribution of the bezoar. The arrow indicates the area where it was probably first domesticated, resulting in the goat as we know it (From Mason 1984)

Fascinating science and valuable results probably await those willing to study this hardy, handsome creature and to explore the reharnessing of its genetic endowment. Today the bezoar is considered merely a trophy for hunters. The power of its genes to refresh - perhaps even revolutionize - the world's 500

million goats has been lost to sight.

RESEARCH AND CONSERVATION NEEDS

The microgoat's potential has hardly been realized. More research on performance and husbandry is needed to preserve and restore small breeds. Selective breeding for prolificacy, viability, and rapid growth, as well as more selective on-site culling, could greatly improve both meat and milk yields and quality.

Management systems that exploit smallness, stabilize production, and preserve the environment should be introduced and publicized in appropriate goat-rearing areas. Careful assessments of indigenous management methods should be made, particularly emphasizing their desirable characteristics. Improving hygiene in the wet season and supplemental feeding in the dry season are also important, as are disease- and parasite-control measures.

The undomesticated ibex and markhor could possibly be major contributors in the development of new, useful breeds for tropical and arid regions (see sidebar, page 42).

REPRESENTATIVE BREEDS OF MICROGOATS

West African Dwarf (Djallon)

West and Central Africa. Female 20 kg; male 30 kg. Adapted to humid lowlands, this widespread goat is particularly valuable for meat and skin production. Generally, it is bred for meat, but milk is sometimes an important secondary product. Sexual maturity is very early (3-6 months), and quadruplets occasionally

occur (most goat breeds normally produce only single births). Related types go by the names "Cameroon Dwarf," "Dirdi," and "Nigerian Dwarf."

Nubian Dwarf

United States. 35-40 kg (often less). A stable miniature variety of the milking Nubian, this microgoat has been developed recently in the United States by crossing standard-sized Nubians with the West African Dwarf. It combines a good milk output with high levels of butterfat.

American Pygmy

United States. 15-25 kg. Derived from the West African Dwarf, it is noted for its hardiness and good nature, good milk production, and adaptability to various climates. There are several varieties, some for milking, others for meat.

Sudanese Nubian

Northern Sudan. 25-30 kg. Widespread milk goats of riverain and urban areas.

Sudanese Dwarf

Southern Sudan. 11-25 kg. A very hardy desert goat similar to the West African Dwarf, it averages 15 kg, but some mature individuals may weigh as little as 11 kg. Used for meat and hides, it produces little milk.

Small East African

Kenya, Uganda, Tanzania. 20-30 kg. A widely neglected meat and hide animal found over a wide range, it is fast growing (sexual maturity at four months) and extremely hardy.

Mauritian

Mauritius. 25-30 kg. A prolific, year-round breeder raised for meat production, it is often confined in simple shelters from birth to slaughter. Perhaps because of this isolation, mortality is less than 10 percent, even with little or no veterinary care.

Criollo

Latin America. "Criollo" is a name given to several breeds of ancient Iberian blood with local adaptations to many unfavorable conditions. They are often small and hardy.

Creole Caribbean. Females 20 kg; males 25 kg. Robust meat goats of Spanish or West African origin that are kept throughout the Caribbean.

Crioulo Brazil. 30-35 kg. A meat and skin goat derived from Portuguese ancestors, it is hardy, prolific, undemanding, and adapted to harsh environments.

Chapper

Pakistan. Female 20 kg; male 24 kg. Originating in dry regions, this meat and milk goat is a nonseasonal breeder with outstanding potential.

Barbari

Pakistan, India. Females 20-25 kg; males 20-40 kg. A prolific, fastgrowing "urban" goat with high twinning and low mortality. Often kept inside houses, they adapt well to confinement and are important for both milk and meat.

Gaddi (White Himalaya)

Hill districts of northern India. 25-30 kg. Kept for meat and their long, lustrous white hair, they are pure-breeding and healthy.

Changthangi (Ladakh)

Kashmir, India. Male 20 kg. A pashmina (cashmere) goat of India, it is adapted to a high altitude, high humidity climate with extremes of temperature.

Terai

Nepal. 8-12 kg. A very small, hardy animal of the southern lowlands, it kids year-round (sometimes twice), and often produces twins.

Southern Hill Goat

Nepal. 12-16 kg. A small, mid-altitude goat resembling the Terai.

Black Bengal (Teddy, Bangladesh Dwarf)

Eastern India and Pakistan. Female 10 kg; male 14 kg. A widespread, humid-area, meat goat that is early maturing and very prolific. It kids twice a year, and produces 60 percent twins and 10 percent triplets. It produces a superior leather.

Katjang

Southeast Asia, China, and Pacific Islands. In places, less than 20 kg. A widespread, highly variable, hardy goat adapted to humid conditions, it usually has twins or triplets. Used for meat and skins, with exceptional females being milked.

Chinese Dwarf (Tibetan, Jining, Fuyang, or Chengdu Grey)

China. 20-40 kg. Well adapted to the humid tropics, it normally twins and is a good meat producer.

Heuk Yumso

Korea. Female 25 kg; male 35 kg. A prolific cold-climate goat with a year-round breeding season. The meat is highly prized, and often sells at a premium due to its supposed health-giving effects.

Hejazi

Middle East. Female 20 kg; male 20 kg. A meat goat, usually black, for harsh desert conditions.

Sinai (Black Bedouin)

Sinai, Egypt and Negev Desert, Israel. Female 20 kg; male 50 kg. Native to dry, hot deserts, this milk and meat goat matures at 5-8 months and has a twinning rate over 50 percent. A most important characteristic is its drought tolerance. The

female, for instance, can drink only once a day - at a pinch, once every other day - without losing appetite or reducing milk flow.

WILD RELATIVES

Several wild relatives will cross with the goat. Surprisingly, they have the same chromosome number (2n=60), and the offspring are frequently fertile. Although essentially unknown to agricultural science, these hybrids may offer a new gene pool for creating new farm animals and for improving the world's goats. They seem to combine the self-reliance of wild species with the usefulness of domestic ones. Artificial insemination and other modern techniques could make them easier to produce today than ever before.

Ibex*

A project in Israel has already produced a cross between the goat and the Nubian ibex (Capra ibex). The Sinai Desert goat, the breed that was used, ranks next to the camel in its ability to go without water - it often drinks only twice a week - but its meat has such a strong flavor that most people consider it dreadful. On the other hand, the ibex is compact and muscular and produces tender, mild meat that steak lovers find delicious. The product from crossbreeding the two is a creature seemingly able to endure extreme temperatures and drought, make use of poor pasture, and produce wonderful steaks.

A herd of several hundred of these hybrids (dubbed 'ya-ez") has been created at Kibbutz Lahav in the northern Negev Desert area. Both sexes are fertile, and they can be bred with each other or with either parent. The meat is already in demand

on the menus of elegant Tel Aviv hotels.

Markhor**

In Pakistan's northern uplands, it is not uncommon to find hybrids between domestic goats and the mountain goat known as "markhor" (Capra falconeri). Each year in Chitral and Gilgit, they can be found in the goat markets.

Markhors inhabit high elevations in rugged mountains and thrive on diets so meager as to be useless to goats. The hybrids are produced when markhor males - perhaps ousted by more dominant males - come in contact with feral domestic goats. However, some farmers raise young markhor and goats together (to overcome mutual resistance) and produce their own hybrids,

For a single hybrid animal local goatherds pay up to 5,000 rupees, a princely sum in this impoverished region. Traditionally, villagers have kept them as stud animals. They appreciate the animal's genetic endowment. Markhors tolerate extremes of cold and snow, are nimble and skilled at escaping predators, and survive on scanty fodder, Moreover, they have a high reproduction potential because they generally produce twins. As a result, they also tend to give more milk and it is rich in nutritive value. Instead of long body hairs, markhors possess insulating underfur - a soft and valuable raw material for the famous Kashmiri shawls.

Apparently, the hybrids can possess many of these qualities together with a calm disposition. Thus they could be useful in themselves and as conduits for passing such traits on to goats.

3 Microsheep

Among the hundreds of breeds of sheep (Ovis aries) in the world, those weighing less than 35 kg when mature have been largely ignored. Although these are common, the impression lingers that they are too small to be useful. Yet this virtually untapped gene pool is esnecially well adapted to traditional Third World animal husbandry. Given attention, these "microsheep" could boost meat, milk, skin, wool, and pelt production in many villages and small farms of Africa, Asia, and Latin America.

Many microsheep thrive in environments that tax the ability of larger breeds to survive. They are adapted to poor feeds and can be grazed in uncultivated wastelands unsuited to any other livestock except goats or camels. Because of their size, microsheep can fatten in areas where forage is so scattered and sparse that larger animals cannot cover enough ground to fill their bellies each day. In addition, their foraging complements that of other livestock. For example, sheep can graze rough grasses and weeds that cattle find unpalatable. Some survive even the stress of extreme aridity and for this reason are the predominant livestock in North Africa and the Middle East.

Many small breeds can be disease resistant. Some, for example, are widespread in the zones of Africa where trypanosomiasis is prevalent. They are generally less adversely affected by foot-and-mouth disease than are cattle, and some small native sheep seem to have fewer problems with insects and parasites than do most other livestock, including temperate-area sheep.

Giving more attention to the management and improvement of microsheep could

pay back abundantly in the form of food, income, and improved land utilization in many parts of the developing world.

AREA OF POTENTIAL USE

Worldwide, but notably in drier regions of the tropics.

APPEARANCE AND SIZE

An average weight for temperate sheep breeds is about 70 kg,' but the smallest microsheep weigh less than 20 kg fully grown. Many tropical microsheep are "hairless," and have little or no wool. These are often difficult to distinguish from goats, but (like all sheep) they generally have blunter snouts, more fat, and hanging tails. Some have greatly enlarged rumps or tails that store fat. Unlike goats, sheep have no odor-producing glands.

Some representative microsheep are described at the end of this chapter.

DISTRIBUTION

More than one billion sheep occur worldwide, and they occupy every climatic zone in which people live. At least half are in developing countries.

STATUS

Although more than 1,000 breeds are recognized, only a handful dominate the world's sheep industries. Lesser-known breeds are rapidly becoming extinct (especially in developed countries, although scattered efforts are being made to

preserve them). Elsewhere, genetic resources have not been properly evaluated, and potentially valuable stock is being lost before it is even understood.

HABITAT AND ENVIRONMENT

Sheep are among the most adaptable animals. Various types are kept in areas of extreme heat, cold, altitude, aridity, humidity, and rainfall. They are especially widespread in hot, dry climates, but some breeds also thrive in humid areas.

BIOLOGY

Sheep make efficient use of a wide variety of fodder: tree leaves, fortes, grasses, crop residues, and agricultural by-products, for instance. They often survive privation by calling on their reserves of body fat.

In the tropics, sheep reach sexual maturity in about a year. Many breeds lamb year-round, which allows for a continuous production of premium meat. Gestation takes about five months, and lambing is usually timed to occur when feed is most abundant and nutritious. Microsheep often bear two or more young and, under good management, may produce lambs annually for more than five years.

BEHAVIOR

These shy animals flock together and, in general, are managed with little effort. They are easily panicked, however, and rams can become aggressive during rutting or when threatened.

THE LITTLE SHEEP THAT COULD

Dozens of the world's neglected breeds of tiny sheep should be preserved from extinction, for many will undoubtedely prove to have outstanding qualities. Current efforts to save the Navajo sheep in the United States exemplify what can be achieved

The Navajo is a microsheep, and is perhaps the oldest breed of sheep in the United States. It may have been introduced to North America in 1540 by the Spanish explorer Francisco Vazquez de Coronado, who was seeking the mythical Seven Golden Cities of Cibola in the region that is now Arizona and New Mexico. Smaller than many dogs, a full-grown Navajo sheep may weigh only 30 kg, but it became a big part of the culture of the Southwest. Although the Navajos and other local Indians had never seen sheep before the 1500s, they soon became shepherds and weavers, and their rugs made from the unique wool of this wiry little animal remain famous even today.

Navajo sheep have white or brown wool hanging in ringlets around their bodies. The fleece is a double coat: long, coarse guard hairs on the outside and short wool on the inside. It yields warm, waterproof, and long-lasting products. Many of the sheep have four horns because the Indians believed that this trait was sacred, and they favored four-horned rams for breeding purposes.

The number of Navajo sheep was reduced sharply between 1950 and 1950 because of severe overgrazing and replacement by improved wool breeds. In recent times there has been so little commercial and scientific interest in this microsheep that by the 1970s only a handful of purebred specimens survived. Since the late 1970s, however, Lyle McNeal, a Utah State University professor, has been working to save it from extinction. By 1988 he had a burgeoning flock at the

university and was learning that this supposedly obsolete dwarf is amazingly useful.

The breed originated in the arid south of Spain (where it is called the "churro"), and it thrives in the hot, dry climate. Unlike normal breeds, it can exist in the desert without supplementary food and with little water. As McNeal has pointed out, any sheep that can survive and raise a lamb in the aridity and searing heat of the American Southwest has to be superior. He has found that the ewes have a strong maternal instinct, which is vital for protecting lambs against the coyotes that are common in the region.

Thanks to the efforts of McNeal and his colleagues, Indians are beginning to use Navajo sheep again; by 1988 there were more than 400 on the Navajo reservation, with their wool fetching premium prices. This tough little sheep could prove valuable not only for American Indians but for poor people in many other dry regions as well.

USES

Microsheep are mainly kept for meat production, but - especially in arid regions - for milk as well. Their meat is usually lean with little "muttony" taste.

Wool or hair is taken from many breeds, although the yield is often small. Skins from hair sheep' thinner than cowhide, are widely used and are in international demand. In some places, manure is considered an important product. In Nepal, thousands of small sheep are used as pack animals, especially to carry salt into mountain valleys.

HUSBANDRY

Most sheep are maintained in free-ranging flocks. Many are grazed (often tethered) over a small area during the day and confined in a "fold" at night. Others are penned or kept as village scavengers. These are usually fed supplements of household scraps.

Sheep form an integral part of a mixed farming economy; for example, they may graze pastures during the wet season, and survive on crop residues and field weeds during the dry season. They have excellent foraging capabilities and are often kept alongside goats. This broadens the variety of forages utilized and often increases total production from a single piece of land, for sheep and goats have complementary feeding habits and male goats help protect the sheep from some predators.

In spite of the heavy toll that predators (such as feral dogs) can take on lambs and ewes, the largest proportion of sheep in the tropics are lost through lack of basic care. Modest supplemental feeding of lambs and inexpensive preventive medicines can do much to lower mortality and boost production.

ADVANTAGES

Sheep are multipurpose animals, and almost everywhere they produce several products. The rich milk is often preferred to that of cows or goats, especially for making cheese and yogurt.

Lambs form an important part of the household economy for much of the rural world, and only rarely is social or religious stigma attached to keeping or eating

them. Indeed, sheep are the traditional feast animals of several religions, and in some places sheep meat is preferred to beef and sells at a premium.
By and large, all sheep products can be processed, utilized, or marketed by the producer. In addition, sheep marketing and transportation systems exist in most countries, at least to some degree.

Sheep are efficient producers and can provide a quick turnover for food and cash. On the brush and coarse grasses of marginal lands, they may be more productive than cattle, and on grass they may outproduce goats. As long as they are not overstocked, sheep do not degrade vegetation; unless starving they will not debark trees. Small breeds cause little erosion, even on steep slopes, heavily traveled paths, or near water holes.2 In South Asia, they have been continuously stocked on the same ground for thousands of years without causing apparent harm.

Because sheep have a natural tendency to accumulate fat, they "finish" well on grazing and usually do not require a high-energy finishing diet.

LIMITATIONS

Despite their general healthiness, sheep are affected by many internal parasites and diseases, a few of which are communicable to man. They are especially susceptible to infectious conjunctivitis (pinkeye).

Predators and thieves can be greater threats than sickness. Labor inputs can be high because of the almost continual protection sheep need.

Some mutton has a strong taste that many find unappealing. However, the taste is

carried mainly by the fat, and the generally lean microsheep are often commended for their fine-textured, sweet meat.

RESEARCH AND CONSERVATION NEEDS

The numerous breeds of small sheep should be investigated. Assessments should be made for the animals' ability to thrive under adverse conditions and for resistance to particular diseases and parasites.

As noted, even minimal extension services and veterinary support for sheep could greatly decrease mortality, especially among lambs.

Improving microbreeds without increasing their size is one of the most interesting challenges facing sheep scientists today. While efforts should be made to conserve and select within types, research should also be conducted on hybrid vigor. Efforts to improve the pelt and fleece of microsheep should also be encouraged.
More studies on the interactions between sheep and cropping systems are needed. Sheep (and the manure they produce) could become important components of forestry (see sidebar), crop rotation, alley cropping, and other forms of sustainable agriculture. For instance, sheep are especially effective for weed control in plantation crops such as oil palm and rubber as well as in forests.

SMALL SHEEP IN THE FOREST

Even in countries with long traditions of raising large sheep, there are opportunities for using small, agile, hardy breeds. The following is an example.

Seeking safer methods for stopping brush from smothering newly planted trees,

U.S. government foresters have turned from chemical defoliants to flocks of sheep. Court decisions in 1983 and 1984 barred the use of herbicides along Oregon's Pacific Coast. Various alternatives were tried, and the animals proved the most successful. Sheep are now the favored method for controlling unwanted vegetation. Indeed, they have changed the foresters' whore approach to managing reforestation.

Formerly, the U.S. Forest Service allowed the brush to grow on logged-over sites and then sprayed it down before planting tree seedlings. Now it plants grass to suppress brush and reduce erosion. The sites are later fertilized, tree seedlings are planted, and within a year sheep are brought in to graze.

Today, in the district around Alsea, Oregon sheep nimbly skirt old stumps to graze on the lush vegetation. Three times each summer since 1984, about 2,000 sheep have been guided across the replanted areas by a herder and a range conservationist. The sheep eat both the grass and the new buds on brush, but they leave most fir-tree seedlings untouched. The key, according to Rick Breckle, a forester, is to have enough sheep to graze an area evenly and to keep them moving so they don't resort to nibbling the young trees.

Previously, chemical brush treatments had annually cost $135-$353 per hectare. Now, sowing grass and grazing sheep costs about $300 per hectare. And there is a product to sell: the adult sheep don't fatten well, but the lambs bring a useful income at the end of the summer. What is more, Breckle reports that the trees seem to be growing faster - probably because of the manurings they receive.

This method seems likely to be effective elsewhere - at least with trees that are

unpalatable or too tall for their growing points to be nibbled. Malaysia, for instance, doubled its sheep population between 1986 and 1989, in part because it has begun raising sheep between the trees in rubber plantations. With the use of agroforestry increasing worldwide, small sheep could find a whole new application.

REPRESENTATIVE EXAMPLES OF MICROSHEEP

West African Dwarf

Senegal to Nigeria, and south to Angola. Female 25 kg; male 35 kg. Well adapted to warm, humid conditions. Prolific, and good disease resistance. Major meat producer in West Africa. Fast growing: by six months of age they approach adult weight.

Landim (Small East African)

East and Central Africa. 23-40 kg. Prolific, adaptable, long fat-tailed type. Large litter size for a sheep. In one recent test, ewes averaged more than 1.4 lambs.3

Berber

Atlas Mountains. 25-41 kg. Needing little feed and remaining constantly outdoors, these extremely hardy sheep are exploited for meat and their coarse, hairy wool. They fatten easily when well fed.

Arab

North Africa. 40-50 kg. This thin-tailed sheep is exceptionally robust, and is resistant to extremes of temperature, drought, and poor nutrition. Primarily a meat producer, its wool is used for coarse cloths and carpets.

Southern Sudan Dwarf

One of the many small breeds of eastern and southern Africa, its weight ranges from 15 to 25 kg, but it may weigh as little as 11 kg. Yielding a fine, short fleece, this hardy, frugal sheep is often run with cattle to maximize grazing.

Hejazi

Deserts of Arabia. 32 kg. A popular and ancient fat-tailed meat producer that is highly acclimatized to drought and privation.

Zel (Iranian Thin-Tailed)

Caspian region of northern Iran. Female 30-32 kg. Well adapted to subtropical regions, they produce coarse wool, milk, and excellent meat that lacks the "mutton taste" and odor of some sheep meats.

Greek Zackel

Mountain and island types. Female 30 kg; male 40 kg. These common sheep are active, hardy, and resistant to extremes of climate and disease. Primarily a milking sheep, their wool is used locally and lambs are slaughtered for special occasions.

Sitia

Crete. Female 25 kg; male 30 kg. Another of the hardy, screwhorned "zackel" sheep common to the Balkans, they are adapted to poor pasturage and extensive herding. Quick maturing and highly fertile, they can be exploited for milk as well as for meat and coarse wool.

Common Albanian

Female 25 kg; male 35 kg. Similar to the Greek Zackel, they are used as triple-purpose animals: meat, milk, and wool. They survive in low, marshy areas where parasites are common.

Zeta Yellow

Yugoslavia. Female 25 kg; male 35 kg. A small, hardy sheep used for milk and some meat, its primary product is wool. Often unshorn for several years, the long fibers are woven into expensive carpets.

Pag

Yugoslavia. Female 20-30 kg; male 25-35 kg. These wool, milk, and meat sheep are frugal and well adapted to scant vegetation and rocky terrain. Although they have a low birth rate and carcass yield, their milk and wool are commercially exploitable.

Roccia (Steinschaf)

Northern Italy, Austria. Female 30 kg; Male 30-35 kg. These "stone sheep" resemble a goat in their ability to exploit the poor pastures of high, steep, rocky

mountains. Although not highly productive, they are hardy and frugal and commonly produce twins.

Corsican

Corsica (France). 25-30 kg. A hardy native breed that is well adapted to rather sparse feed conditions. Coarse wool, both white and black, is well suited for hand processing.

Entre Douro e Minho

Portugal. Female 15-18 kg; Male 20-25 kg. These independent sheep yield a good wool in mountainous terrain that would otherwise be nonproductive.

Churra do Campo

Portugal. Female 20 kg; male 30 kg. A coarse-woofed sheep extensively kept in Portugal's dry interior for milk and wool.

Galician

Spain. Female 18 kg; male 25 kg. A milking breed that survives on poor pasture, it also produces a marketable wool.

Soay

Scotland. Female 25 kg; male 30 kg. Adapted to wide temperature variations. Possibly the most primitive domesticated sheep of Europe, probably unchanged

from Viking times. Immune to foot rot. A wool sheep with short brown fleece that is shed annually.

North Ronaldsay (Orkney)

Northern Scotland. 27-32 kg. Surviving year-round on seaweed, this rare breed is adapted to high salt intake and the associated digestive problems. Yield 1-2 kg medium-coarse wool.

Criollo

Latin America. Derived from ''native'' Spanish Churro and Merino sheep. Many are small and very hardy.

Navajo-Churro Southwestern United States. Female 45 kg; male 70 kg. Maternal, and very resistant to internal parasites and hoof rot. Although the Navajo subsists and reproduces on little feed and scarce water in desert regions, it was widely replaced by improved breeds earlier in this century. Because of its hardiness, however, and the use of its wool in traditional weaving, its numbers are rebounding (see sidebar, page 50).

Florida Native Southeastern United States. Females 35-45 kg; males 45-6O kg. This long-isolated and highly variable sheep is adapted to harsh subtropical climates and is known for its ability to forage. A medium-wool breed, it is very resistant to intestinal parasites. Verging on extinction due to neglect and uncontrolled crossbreeding.

Virgin Islands White Hair (St. Croix)

Caribbean. Female 35-45 kg; male 45-55 kg. Hair sheep with some wool in young animals. Well adapted to warm humid conditions, it has fairly good disease and parasite resistance and produces good meat. Prolific, it breeds most of the year and commonly has twins.

Magra (Chokhla)

Northwest India, Pakistan.4 20-25 kg. Adapted to hot, dry areas, the extremely white and shiny fleece is valued for carpet wool. Slowmaturing and low fertility (lambing at 45 percent) plus extensive crossbreeding have led to serious declines in population.

Marwari

Northwest India. 25-30 kg. A widespread, white-fleeced sheep that has a high resistance to disease and worms, good fertility, and low mortality. They do well in large flocks.

Mandya (Bandur)

Southwest India. Female 25 kg; male 35 kg. An outstanding meat breed with good mutton quality, it adapts well to mixed farming and has unusually low lamb mortality.

Hu (Huyang, Lake Sheep)

China. Female 35 kg; male 45 kg. These fat-tailed sheep have a six month lambing interval and are very prolific. They are used under intensive management to

produce meat, wool, and a valuable lambskin.

Javanese Thin-Tail

Indonesia. 25-40 kg. Widely held as a "bank account," these meat, manure, and skin sheep are well known for being prolific. Although single lambs are not uncommon, litters of six have also been recorded.

WILD AND WOOLLY

Considering that dozens of countries depend on the productivity of more than a billion domesticated sheep, it is remarkable that their wild ancestor is accorded no attention. This fast-declining animal is now little more than a trophy for hunters, a fact that should be of vital intemational concern.

Sheep were domesticated in the Middle East and Central Asia in the Stone Age era between 8,000 and 11,000 years ago.* Their wild ancestor was almost certainly the mouflon (Outs orientalis). However, domestication may have occurred in more than one place, and two other wild creatures, the urial (Outs vignei) and the argali (Outs ammon), also possibly provided genes to some sheep breeds.

The mouflon, urial, and argali still exist in the mountains of Central Asia, and a European subspecies of mouflon is also found in the Mediterranean, but only on Corsica, Cyprus, and Sardinia. Because they live in remote, rugged, upland areas, these wild sheep are usually undisturbed, but the numbers are decreasing everywhere.**

This may be a serious loss because these animals could be extremely valuable.

They are capable of crossing with domestic sheep, and the offspring are viable and fully fertile.* For developing new meat-producing breeds, their potential seems almost limitless.**

During the thousands of years that sheep have been protected by humans, their wild ancestors have continued to face predators, parasites, disease, extreme cold and seasonal starvation. Their genetic endowment, forged and tempered in unforgiving harshness, could be a benefit for all future sheep generations. These animals appear to resist various diseases. Their meat is reported to be of excellent quality, notably lacking the strong mutton flavor that many people find objectionable. They have relatively short, thin tails - a feature that might eliminate the need for docking (tail removal) in the domestic flock. Some (for instance, the Asian mouflon and the urial) have rates of effective reproduction up to 1.6 lambs per ewe, more than twice the average of most domestic types, especially under the conditions where these wild creatures live.

That mouflon and other wild sheep could have practical utility is suggested by research at Utah State University. Scientists there have mated mouflon with farm sheep to create sheep better able to defend themselves against coyotes and other natural dangers. Half-wild, half-tame sheep hybrids have existed on a ranch in southern Utah for the past decade. Also, in Cyprus similar mouflon x sheep hybrids have shown considerable promise.

At the very least, this wiry little mountain sheep could be a model for educating students and the public. It is a living reminder of the fantastic changes that can be induced in animals by selection for various traits. Also, it is a "map" to the history of sheep domestication. Studies of mouflon genes, blood immunology,

morphology, physiology, horn structure, skeleton, fleece, temperament, and a host of other features would help unravel the ancestry. These studies and various biochemical analyses would be a fascinating contribution to agriculture, science, history, and the public perception of the origins of our natural resources.

Genes from wild sheep are not likely to quickly benefit wool production. Lack of fleece is one reason why these creatures have been neglected but throughout most of Asia and in North Africa, sheep are bred primarily for meat and milk, and there is a growing worldwide interest in the use of hair sheep. All of this brings new possibilities for the use of this old resource.

4 Micropigs

FIGURE

Most breeds of swine (Sus scrofa) are too large to be considered microlivestock, but there are some whose mature weight is less than 70 kg. These micropigs are particularly common in West Africa, South Asia, the East Indies, Latin America, and oceanic islands around the world. At least one, the Mexican Cuino, may weigh a mere 12 kg full-grown.

Many miniature swine have been developed for use in medical research, but their agricultural potential has been largely ignored. This is unfortunate, for micropigs of all types - native, feral, and laboratory - deserve investigation. Swine provide more meat worldwide than any other animal, and micropigs are potentially important sources of food and income for poor people in many parts of the developing world.

Smallness makes for nimble and self-sufficient pigs, in contrast to large, lethargic breeds. Small breeds are easier to manage and cheaper to maintain; the threat of injury from angry or frightened animals is lessened; and the sows are less likely to crush newborn piglets, often a major cause of mortality in large breeds. Some micropigs - particularly those from hot regions or wild populations - also have a higher resistance to heat, thirst, starvation, and some diseases.

Pigs adapt to a wide variety of management conditions, from scavenging to total confinement; some are even kept indoors.2 They gain weight quickly, mature rapidly, and help complement grazing livestock because they relish many otherwise unused wastes from kitchens, farms, and food industries, as well as other foods such as small roots, leafy trash, or bitter fruits that are not consumed by humans or ruminants.

For these reasons, micropigs could become useful household and village livestock in the developing world, and they deserve greater attention than they now receive. Although their growth may not be as rapid as that of improved breeds raised under intensive commercial production, with modest care and minimum investment, backyard micropigs can produce sizable yields of meat and other products, as well as improved income for rural and even urban populations.

AREA OF POTENTIAL USE

Worldwide, especially in warm, humid areas.

APPEARANCE AND SIZE

Like full-sized breeds, micropigs are stout-bodied, short-legged animals with small tails and flexible snouts ending in flat discs. Examples of some micropigs are listed at the end of the chapter.

DISTRIBUTION

Domestic pigs are found all over the world, but their concentrations vary greatly. Africa has the fewest per capita, but in recent years they have gained increasing favor in the sub-Saharan regions. In Latin America, pigs have long been a major component of backyard agriculture. In the Middle East, an early center of domestication, pigs are not widely kept today because of religious dietary restrictions. In the Ear East, they are the major meat source, and China has more pigs than any other country. And in the Pacific region, pigs and chickens are often the only meat available.

STATUS

Pigs are becoming more popular: their worldwide numbers increased by about 20 percent in the 1970s. However, in most countries commercial pig production has focused on a mere handful of breeds, and much genetic diversity is unstudied or even threatened with extinction. Some microbreeds have already been lost, and others are dwindling in numbers.3 Many European breeds have been completely lost. The Cuino and some other Latin American criollo types are threatened, as are most of Africa's traditional breeds. China, however, has made notable efforts to preserve its native types.

HABITAT AND ENVIRONMENT

Although, as previously noted, pigs are found all over the world, they are in general adapted to warm, humid climates where many other livestock species are more susceptible to diseases and environmental stresses. They are also raised at high altitudes, such as in the Andes and Tibet. Although there are few climatic limitations to pig production, only about 20 percent of the world's pigs are currently kept in the tropics.

BIOLOGY

Pigs are omnivores, willing and able to eat almost anything.4 Unlike most other livestock, they eat their fill and sleep as the food digests, allowing humans to establish a convenient eating and sleeping schedule.

Pigs are prolific; a few Chinese breeds routinely have litters of 20 or more. Micropigs are no exception; litters of 6-10 are common. Piglets gain weight

rapidly and can be weaned after a few weeks. Sexual maturity is sometimes attained as early as 4-6 months, depending on breed and environment. Pigs are usually slaughtered at 67 months of age, allowing them to be produced on an annual cycle. They can live 10-20 years.

Because of their smaller size, micropigs have a relatively greater skin-to-weight ratio than today's commercial breeds, and therefore they probably shed heat more effectively. Certainly they seem to perform better in tropical heat and humidity, which normally keep the heavier types from reaching their maximum productivity. Studies have suggested that an optimal size for some tropical environments - because of metabolic and feed efficiency - may be less than 65 kg.5

BEHAVIOR

Pigs are social animals; they enjoy companionship and ferociously defend their young and sometimes even the humans who care for them. They are employed as guard animals in some areas and have been used extensively in behavioral research.

Contrary to common belief, pigs are clean and tidy if provided adequate space. Larger breeds, however, wallow in mud to stay cool in hot weather and require a wallow or shade (except for some Latin American types, which seem less susceptible to heat). Some lightcolored pigs sunburn easily.

Pigs will dig up earth with their mobile snouts; some breeds do it constantly.

USES

Fresh pork is the major pig product in tropical areas. It usually fetches premium prices, and in many places (such as the Pacific Islands and China) it is the most important red meat available to rural people. Nutritious and tasty, it is one of the easiest meats to preserve, needing only salt or melted fat. Processed products such as bacon and sausages can be important for both home consumption and cash sales.

Pig fat (lard) is a good source of food energy, and can substitute for cooking fats and oils. It is easily melted and clarified, is widely used to make soap, and is a valuable commercial product.

Pig skin, once degreased, is easily tanned into leathers that are popular for garments, shoes, and other products demanding soft, light, and flexible leathers.

Pig manure is a good fertilizer. Because the animals are often kept in confinement, it can be easily collected.

HUSBANDRY

In many places, pigs are kept as free-roaming scavengers. They can be trained (by coaxing with feed, salt, or affection) to keep close to home, thereby helping to minimize destructive scavenging.

Herding is a higher level of management that requires more effort, but it allows pigs to be integrated into other types of agriculture while utilizing feeds that otherwise go to waste.

Because their exercise needs are minimal and dominance is quickly established

within litters, pigs are the easiest hoofed livestock to raise in small enclosures (sties). However, fencing must be secure, and if sties are small, the animals must be moved frequently to prevent diseases and parasites from building up.

ADVANTAGES

Pigs are well-known, often traditional, animals in many areas, and people usually do not have to be taught how to manage and use them. Efficient scavengers, they can live, grow, and reproduce with a minimum of investment or specialized care.

Pigs are highly efficient converters of feed to meat. They can provide the greatest return for the least investment of any hoofed livestock because of their fecundity, low management costs, broad food preferences, and rapid growth.

Pigs normally accumulate fat during adolescent growth (making ''finishing" feeds less necessary). Some micropigs (especially those from feral ancestors) have the ability to quickly mobilize and store these body-fat reserves; in times of extreme scarcity, it aids their survival.6

Pigs work well in multiple-cropping schemes. They are often used to help clear small plots by uprooting weeds, shrubs, and even small trees. In Southeast Asia, they are frequently raised in conjunction with aquaculture, their manure providing food for the fish.

LIMITATIONS

If improperly managed or maintained in filthy conditions, pigs may quickly succumb to disease and parasite epidemics. Most diseases are communicated only

among pigs, but some can be transmitted to humans. For this reason, pork should always be fully cooked.

Some cultures never eat pork. Others do, but nonetheless accord pigs and their keepers low status.

Young pigs are vulnerable to many predators.

RESEARCH AND CONSERVATION NEEDS

A major survey of small pig breeds is needed. They have the potential to be valuable producers in their own right, as well as to improve other pig breeds. For instance, they represent a little-known reservoir of disease resistance and climatic adaptation. Governments, research stations, universities, and individuals should make special efforts to preserve types that have outstanding or unusual qualities.

When it is necessary to eradicate feral pig populations (as is common on Pacific islands), representative stocks should be preserved. These rugged animals have been genetically isolated for decades or even centuries and are likely to carry valuable traits for survival under adversity.

Large breeds may be promising candidates for genetic "downsizing," which has already produced the many types of miniature pigs that are used in medical research.

THE LITTLEST PIG

Although this chapter highlights the world's smallest breeds, there exists a pig

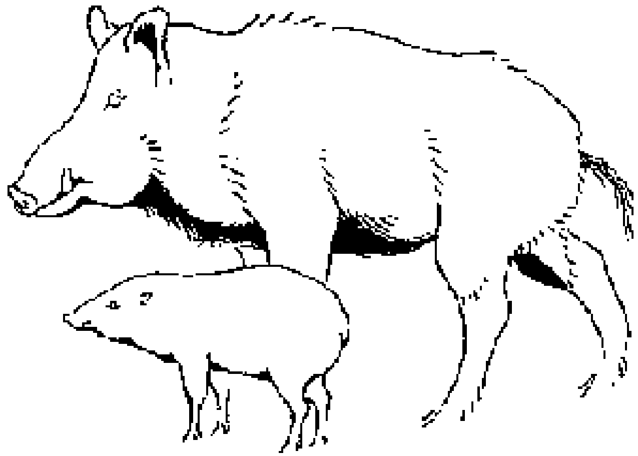
that is even smaller. It is, however, an entirely different species and it is on the brink of extinction.

The pigmy hog (Sus salvanius) is a shy and retiring wild creature of northeastern India. It is merely 60 cm long with a shoulder height of 25 cm, and weighs less than 10 kg. It was once found widely along the southern foothills of the Himalayas. Today, however, it apparently occurs in only one area, the Manas National Park in Assam. Despite this protection and the fact that it is listed among the 12 most endangered species on earth, it still falls victim to hunters and to habitat destruction - especially illegal grass fires.

If saved from extinction, this minute species - barely reaching a person's calf - might become useful throughout the world. Its chromosome number is the same as that of the common pig and its physiological processes are probably also similar. Therefore, were its numbers to be built up, it might become a valued and well-known resource for laboratories and small farms. Its daily food intake and its space requirements are only a fraction of a normal pig's. It probably has exceptional tolerance to heat, humidity, and disease.

This is not a domesticated species, and there is therefore much to learn before its usefulness can be clearly seen. Indeed, whether it can be reared in captivity is uncertain. Some attempts have ended in disaster, but this seems to have been the result of mismanagement.

Before there is any possibility of developing it, however, the pigmy hog must be preserved from ultimate loss. The last specimen could go into a villager's pot at any time now.



Adult male of the common pig (wild boar) and pigmy hog draw to same scale. (W.L.R. OLIVER)

REPRESENTATIVE EXAMPLES OF MICROPIGS

West African Dwarf (Nigerian Black, Ashanti)

West Africa. Mature weights of 25-45 kg are reported. In the humid lowland forests of West Africa this breed has long been kept by villagers, often as a scavenger. Indigenous to the hot, humid tsetse zones of West Africa, it seems resistant to trypanosomiasis.

Chinese Dwarfs

China (and Southeast Asian countries such as Vietnam) has long had small pigs - often characterized by numerous teats and large litters - associated with traditional intensive agriculture as well as scavenging conditions. Some Chinese pigs weighing less than 70 kg are adapted to tropical and subtropical conditions, but the smallest (20-35 kg) live in the cold climates and high altitudes of Gansu,

Sichuan, and Tibet. Small black Chinese pigs were crossed with European types in the early 1800s and produced the foundation stock of many modern Western breeds.

Criollo

There are a number of "native" breeds throughout Latin America commonly known as "criollo." Many are quite small. Although, apparently, they are slow to mature and bear small litters, they adapt well to environmental extremes and are widely kept by rural inhabitants for food and income. Criollos are little studied and are being replaced by imported breeds before their possibly outstanding qualities can be quantified.

Cuino This micropig from the highlands of central Mexico may be descended from small Chinese types and is the smallest domestic pig, weighing as little as 10-12 kg fully grown. Hardy and an efficient scavenger, it can grow quickly when feed - especially corn - is abundant. A century ago the cuing was a widespread household animal and was used for a time for experimental work in central Mexico. It is now little known and could be threatened with extinction.

Black Hairless (felon, Tubasqueno, Birish) These small pigs of central and northern South America survive in hot, humid, adverse climates. They are adapted to bulkier feeds than most pigs and can thrive on fruit wastes. Many local types exist.

Nilo (Macao, Tatu, Canastrinha) This small, widespread, black, hairless pig of Brazil is often kept inside the house.

Yucatan Miniature Swine A subtype of the black hairless from Mexico's hot, arid

Yucatan Peninsula, it was imported into the United States in 1960. It has been downsized for laboratory use in the United States and is known as the Yucatan Micropig (registered). Weight at sexual maturity has been lowered through selective breeding from 75 kg to, currently, between 30 and 50 kg, with an ultimate goal of 20-25 kg. There is no evidence of "dwarfism," stunting, or loss of reproductive performance, and it appears to hold notable promise as microlivestock for developing countries. The parent stock, used for meat and lard production in Yucatan, is renowned for gentleness, intelligence, resistance to disease, and relative lack of odor. Exceptional docility, even in older boars and sows with litters, makes them easy to handle without the need for specialized housing or equipment.7

Other Laboratory Breeds

Other miniature laboratory pigs have potential for tropical use. These include the Goettingen, Hanford, Kangaroo Island, Ohmini, Pitman-Moore, and Sinclair (Hormel). In general they weigh 30-50 kg when ready for slaughter and mature at less than 70 kg.

Ossabaw

United States. 20-30 kg. Feral on Ossabaw Island, South Carolina, for more than 300 years, this pig is well adapted to environmental extremes. Unlike most domestic animals, it can maintain itself in coastal salt marshes. It has perhaps the highest percentage of fat of any pig. The piglets are very precocious, self-reliant, and robust.8

Kunekune (Pua'a, Poaka)

New Zealand. Female 40 kg; male 50 kg. Perhaps of Chinese origin, these black-and-white spotted pigs are docile, slow, and easy to contain. Although late maturing, they can fatten on grass alone. Like other native breeds throughout the Pacific region (for example, the Pauta of Hawaii), stock is being lost through crossbreeding, displacement by other breeds, and eradication efforts.

To find certain disease-resistant genes in poultry it may be necessary to go looking in the backyard chicken flocks in Latin America, Africa, or Asia.
Kelly Klober
Small Farmer's Journal

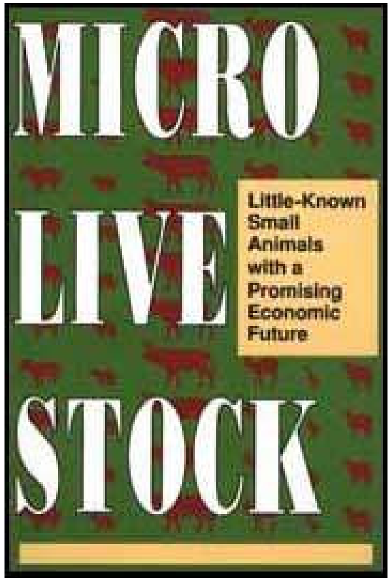
. . . Policies are needed to encourage development of a labor-intensive small-scale livestock sector, which would increase employment and provide a major market for surplus cereals. This sector, however, is particularly restrained by poor technology, poor public support services, and poor marketing channels. Third World livestock production of this type could provide a natural focus for foreign assistance that earlier seemed inappropriate because of concerns about global food scarcity.

John W. Mellor International Food Policy Research Institute

Successful development of agriculture often requires an intimate understanding of the society within which it is to take place - of its systems of values, of its customary restraints.... It has been necessary to understand what incentives the

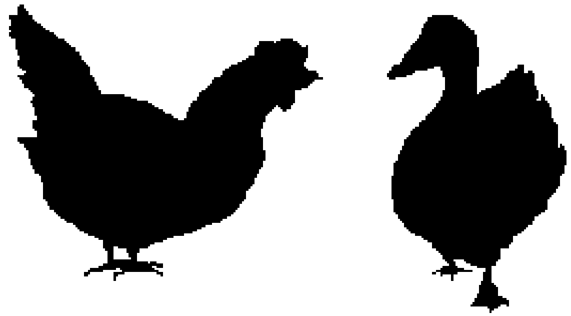
farmer needs to change, what practical difficulties he encounters introducing change, what his traditional pattern of land use is and how this pattern or system can be upset by thoughtless innovation.

John de Wilde
Experience with Agricultural Development in Tropical Africa



Micro-livestock: Little-known Small Animals with a Promising Economic Future (BOSTID, 1991, 435 p.)

Part II : Poultry



FIGURE

Chickens, ducks, muscovies, geese, guinea fowl, quail, pigeons, and turkeys epitomize the concept of microlivestock. Throughout Africa, Asia, and Latin America they are (collectively) the most common of all farm stock. In many - perhaps most - tropical countries, practically every family, settled or nomadic, owns some kind of poultry. In the countryside, in villages, even in cities, one or another species is seen almost everywhere; in some places, several may be seen together. Although raised in all levels of husbandry, these birds occur most often in scattered household flocks that scavenge for their food and survive with little care or management.

Their size bestows microlivestock advantages, including low capital cost, low food requirements, and little or no labor requirements. They are also "family sized": easily killed and dressed, with little waste or spoilage.

These poultry species help meet the protein needs of the poorest people in the world. Some are raised even in areas where domestic cattle cannot survive because of afflictions such as trypanosomiasis and foot-and-mouth disease. Some

are maintained under conditions of intensive confinement - provided a source of feed is available - and can be produced in areas with insufficient land for other meat-producing animals.

In addition, these birds grow quickly and mature rapidly. (For instance, a chicken can, under proper conditions, reach maturity in 26 months.) They adapt readily to being fenced or penned much, or all, of the time. And, compared with the major farm livestock, their life cycles are short and their production of offspring is high. Thus, farmers can synchronize production to match seasonal changes in the availability of feed.

Although poultry contribute substantially to human nutrition in the tropics, it is a small fraction of what it could be. The meat is widely consumed and is in constant demand. An excellent source of protein, it also provides minerals such as calcium, phosphorus, and iron, as well as the B-complex vitamins riboflavin, thiamine, and niacin. Nutritionally as complete as red meat, it is much lower in cholesterol and saturated fats. Poultry eggs are also important sources of nutrients. They are a renewable resource, easy to prepare, and are among the best sources of quality protein and vitamins (except vitamin C).

In spite of their numbers and potential, poultry are rarely accorded primary consideration in economic development activities. All in all, these small birds lack the appeal of large, four-legged livestock. Indeed, most countries have little knowledge of the contribution household birds actually make to the well-being and diets of their peoples. In some countries - even those where birds are widely kept - there is little or no poultry research or extension. And where such programs do exist they usually focus almost exclusively on the production of chickens under

"industrial" conditions near cities (see sidebar, page 75).

Most developing countries now have these intensive chicken industries, in which birds are kept in complete confinement. However, these commercial operations provide food for people in the cash economy, not for subsistence farmers. Moreover, grain is sometimes diverted or imported to maintain these operations, perhaps causing food shortages, higher prices, or depleted foreign exchange. Thus, in this section we focus on other, neglected, aspects of poultry production.,

The neglect of poultry that scavenge around the rural farmhouses and in village yards is understandable. The birds are scattered across the countryside where extension programs are difficult to implement. Their presence is often so ingrained in traditional village life that they are taken for granted and ignored by the authorities.

Yet village poultry deserve greater attention. As converters of vegetation into animal protein, poultry can be outstanding. In fact, it is estimated that, in terms of feed conversion, eggs rank with cow's milk as the most economically produced animal protein, and that poultry meat ranks above that of other domestic animals.

Most Third World poultry flocks live a wary, half-wild existence, scrounging for insects, earthworms, snails, seeds, leaves, and leftovers from the human diet. From dung and refuse piles they salvage undigested grains, as well as insects and other invertebrates. Often the persons who care for them are women or children. Some keep the birds around the house, penning them at night for protection from predators and thieves.

This almost zero-cost production has, in spite of high losses, a remarkable rate of return. Any improvements that require the purchase of supplies cut severely into the profitability. The first step in improving the production of free-ranging poultry is vaccination against diseases (especially Newcastle disease, fowl pox, and Marek's disease) and a modest, supplemental feeding during times of seasonal scarcity.

THE INDUSTRIAL CHICKEN

Throughout modem livestock farming the trend is toward more intensive methods, and poultry specialists have set the pace. In many countries, since the 1920s, barnyard fowl have given way to egg and broiler factories. The old-fashioned chicken reared outside on corn stubbles for 5 or 6 months has been replaced by the broiler, mass-produced in controlled environment houses in 7 - 10 weeks.

As a result of this revolution in poultry raising, small farmers who once made a comfortable living from a few laying hens have been forced out of business. These economic changes have also forced poultry men to have larger and larger flocks to survive. The largest broiler-chicken companies even control their own breed development, feed production, house construction, slaughtering, and freezing, many even have wholesale outlets.

The rapid changes in poultry farming methods can be attributed to the application of advanced technology. The development of the incubator to replace the mother hen sitting her seasonal clutch of eggs was the first mayor step toward intensive poultry farming.

In addition, chickens were the first livestock to receive serious attention from geneticists. Before World War II, it was discovered that crossbreeding selected pure and inbred lines could result in dramatic increases in production. Hybrids tailor-made for egg or meat production quickly ousted the old pure breeds such as the Rhode Island Red White and Brown Leghorns, Light Sussex, and the various crosses among them. Chicken broilers made by crosses involving parents derived from Cornish and Plymouth Rock have supplanted all others.

This situation now prevails in most industrialized countries. The breeding of commercial stocks is in the hands of a few corporations for each commodity (white eggs, brown eggs, chicken broilers, turkeys) and each has national or even global distribution of its hybrid stocks.

A BREAKTHROUGH IN POULTRY HEALTH

Newcastle disease is endemic in developing countries and is a constant threat to poultry. Farmers dread this virus, first identified half a century ago in northern England that brings diarrhea, paralysis, and death to most poultry. It is severe, highly contagious, and can cause 100 percent mortality. When it strikes an area, farmers must kill all chickens - even healthy ones - to stop it from spreading.

Only Australia, New Zealand, Northern Ireland and some Pacific islands are unaffected. But, although the disease is not found in Australia, certain strains of the virus are present in Australian chickens. These strains are completely harmless, but Australian researchers have found that they induce antibodies that are effective against Newcastle disease.

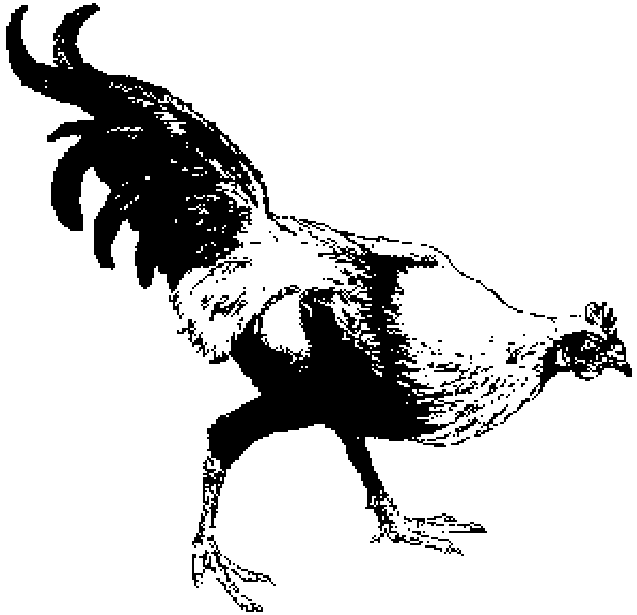
In a joint project (funded by the Australian Centre for International Agricultural Research), scientists from Malaysia's University of Agriculture and Australia's University of Queensland* have put this to good use. They have produced a live culture of the harmless virus that farmers can spray onto feed pellets to vaccinate their birds.

Field tests of the new vaccine, carried out in Southeast Asia, have been extremely promising. Simply coating feeds with the virus seems to be enough to immunize some chickens, which then pass the immunity on to the others in the flock as well as to new hatchlings. In Malaysia, which has 49 million chickens and a population willing to pay a premium for tasty village poultry meat, one economist estimates that the vaccine might increase rural incomes by 25 percent.

Conventional vaccines must be stored under refrigerated conditions, which most villages lack. But the Malaysian workers made the Newcastle disease vaccine tolerant of heat. By selective breeding, they now have strains that resist 56°C for at least 2 hours. Thus, even in the tropics, the vaccine remains effective for several weeks without refrigeration. The researchers have also devised methods for coating the vaccine onto pelleted feeds. Because the virus can withstand heat, they use a machine designed for coating pharmaceutical tablets.

At this stage, the project is showing every promise of producing a cheap means of reducing Newcastle disease losses among chickens throughout much of the world. Already inquiries have come from other Asian countries and from Africa, and it is hoped that the vaccine may eventually benefit many countries.

5 Chicken



FIGURE

Chickens (Gallus gallus or Gallus domesticus)1 are the world's major source of eggs and are a meat source that supports a food industry in virtually every country. There may be as many as 6.5 billion chickens, the equivalent of 1.4 birds for every person on earth.2

No other domesticated animal has enjoyed such universal acceptance, and these birds are the prime example of the importance of microlivestock. Kept throughout the Third World, they are one of the least expensive and most efficient producers of animal protein.

To the world's poor, chickens are probably the most nutritionally important livestock species. For instance, in Mauritius and Nigeria more than 70 percent of rural households keep scavenger chickens. In Swaziland, more than 95 percent of

rural households own chickens, most of them scavengers. In Thailand, where commercial poultry production is highly developed, 80-90 percent of rural households still keep chickens in backyards and under houses. And in other developing countries from Pakistan to Peru, a similar situation prevails.

Clearly, these chickens should be given far more attention. They represent an animal and a production system with remarkable qualities; they compete little with humans for food; they produce meat at low cost; and they provide a critical nutritional resource.

Scavenger chickens are usually self-reliant, hardy birds capable of withstanding the abuses of harsh climate, minimal management, and inadequate nutrition. They live largely on weed seeds, insects, and feeds that would otherwise go to waste.

Unfortunately, however, quantitative information about the backyard chicken is hard to obtain. Few countries have any knowledge of its actual contribution to the well-being and diet of their people. Notably lacking is an understanding of the factors limiting egg production, which is markedly low and perhaps could be raised dramatically with modest effort.

AREA OF POTENTIAL USE

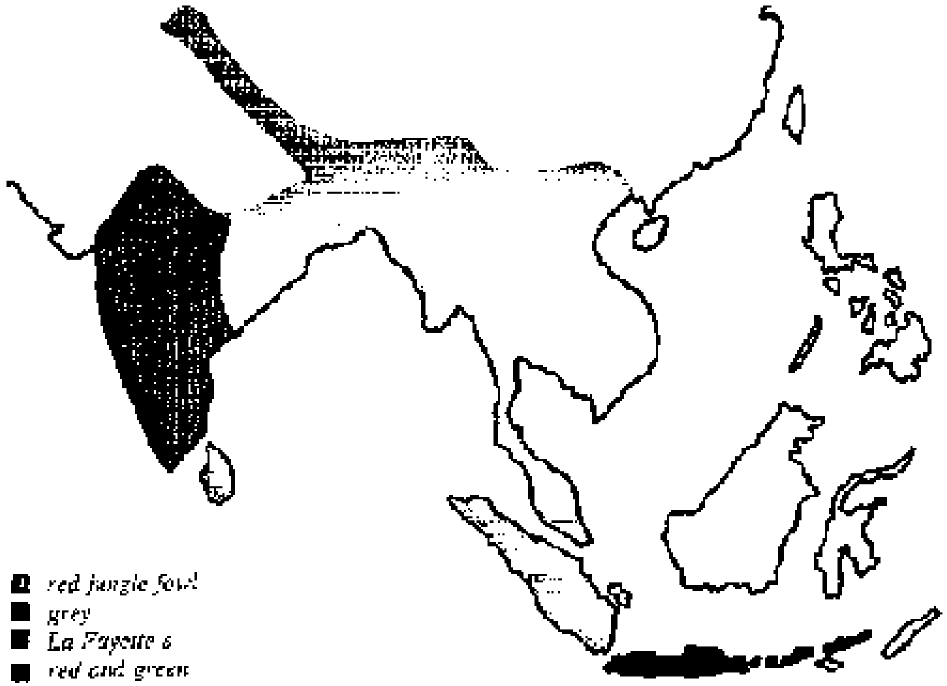
Worldwide.

APPEARANCE AND SIZE

Chickens are so well known and ubiquitous that they need no further description. Varying in color from white through many shades of brown to black, they range in

size from small bantams of less than 1 kg to giant breeds weighing 5 kg or more. Scavenger chickens tend to weigh about 1 kg.

The indigenous chickens of Asia are probably descended directly from the wild junglefowl. Those of West Africa are believed descended from European birds brought by the Portuguese in the sixteenth century; those of Latin America probably descend from Spanish birds introduced soon after the time of Columbus.



Distribution of the red junglefowl, wild ancestor of the chicken, and its related species. Junglefowls were domesticated in Southeast Asia in prehistoric times. Their domestic descendants had reached the Indus valley by about 2500 B.C. and China by about 1400 B.C. They spread into Central Europe, probably also around 1400 B.C. As it spread, the bird became transformed. For instance, although red junglefowls lay only one egg every two or three months, some modern domestic hens lay eggs daily throughout most of the year.

figure

DISTRIBUTION

All countries have chickens in large numbers.

STATUS

They are not endangered, but industrial stocks are replacing traditional breeds to such an extent that much potentially valuable genetic heritage is disappearing.

HABITAT AND ENVIRONMENT

Although chickens derive from tropical species, they adapt to a wide variety of environments. The modern Leghorn, for example, is found from the hot plains of India to the frozen tundra of Siberia, and from sea level to altitudes above 4,000 m in the Andes. (There are, however, hatching problems at such high altitudes because of oxygen deficiency.) They also occur in desert countries such as Saudi Arabia, which has a vast poultry industry and even exports broilers. (However, the birds need shade and a lot of water where it is hot and dry.)

BIOLOGY

Chickens are omnivorous, living on seeds, insects, worms, leaves, green grass, and kitchen scraps.

A commercial bird may produce 280 eggs annually, but a scavenger may produce close to none. Commonly, a farmyard hen lays a dozen eggs, takes three weeks to hatch out a brood of chicks, stays with the chicks six weeks or more, and only then starts laying again.

Egg production depends on daylength. For the highest production rate, at least 12

hours of daylight are needed. The incubation period is 21 days. A hen can begin laying at 5 months of age or even earlier, but in scavengers it may be much later. The average weight of the eggs is approximately 55 g from industrial layers and approximately 40 g from scavengers. Hatching success from breeder flocks often exceeds 90 percent. Industrial broilers can be marketed as early as 6 weeks, when they are called "Cornish hens."

BEHAVIOR

These passive, gregarious birds have a pronounced social (pecking) order. If acclimated, they remain on the premises and are unlikely to go feral. If given a little evening meal of "scratch," they learn to come home to roost at night.

USES

Chickens have multiple uses. They were probably first used for cock fighting; later they were used in religious rituals, and only much later were raised for eggs and meat. Today, chickens can provide a family with eggs, meat, feathers, and sometimes cash.

HUSBANDRY

In different parts of the world, people keep scavenging chickens in different ways. The managers are often women and children because they have more time to spend at home to feed the birds and repel predators. Some people leave the birds entirely to their own devices. Many house them at night. Others take the birds each day to the fields, where they may find much more food.

There are many ingenious local practices. In Ghana, for example, farmers "culture" termites for poultry by placing a moist piece of cow dung (under a tin) over a known termite nest. The termites burrow into the dung, and some can then be fed to the chickens each day. Because termites digest cellulose, this system converts waste vegetation into meat.

A ratio of 1 male to 10-15 females is adequate for barnyard flocks. Hens will lay eggs in the absence of a rooster - but of course the rooster is needed if fertile eggs are wanted.

Removing chicks stimulates the hen to lay more eggs. This results in more chicks being hatched, but it requires that the chicks be nurtured and fed until they are old enough to fend for themselves.

ADVANTAGES

Chickens are everywhere; every culture knows them and how to husband them. They have been utilized for so many centuries that in most societies their use is ingrained. Unlike the case with pork and beef, there are few strictures against eating chicken meat or eggs.

The meat is high in quality protein, low in fat, and easily prepared. In many countries, the village chicken's meat is preferred to that of commercial broilers because it has better texture and stronger flavor. Even in countries with vast poultry industries there is a growing demand for the tasty, "organically grown," free-ranging chicken.

Chickens are more suited to "urban farming" than most types of livestock and can

be raised in many city situations.

The birds are conveniently sized, easily transported alive, and, by and large, do not transmit diseases to humans.

LIMITATIONS

Throughout Asia, Africa, and Latin America, the problems of village chickens are mainly those discussed below.

High Hatching Mortality

Commonly, a hatch of eight or nine village chicks results in only two or three live birds after a few days. A survey in Nigeria, for instance, showed that 80 percent died before the age of eight weeks. Losses elsewhere are known to be similar. This is mostly because of starvation, cold, dehydration, predators (hawks, kites, snakes, dogs, and cats, for example), diseases, parasites, accidents, and simply getting lost - all of which can be prevented without great effort.

Chronic and Acute Disease

Poultry diseases can become epidemic in the villages because there are few if any veterinarians. Newcastle disease, fowlpox, pullorum disease, and coccidiosis, for example - all of which are endemic in the Third World - can destroy the entire chicken population over large areas. Lice and other parasites are also prevalent. Scavengers and industrial birds seem to show no differences in their tolerance for such diseases and parasites.

Low Egg Production

A survey in Nigeria showed that the annual production per hen was merely 20 eggs. Such low production is common throughout the Third World and is caused by a combination of low genetic potential, inadequate nutrition, and poor management. Villagers rarely provide nest boxes or laying areas, so that some eggs are just not found. Some birds have high levels of broodiness, and eggs accumulating in a nest stimulates this. There are indications, however, that some village chickens (for example, some in China) have quite substantial egg-laying potential when provided with adequate feed.3

Low Egg Consumption

In the tropics, many people choose not to eat eggs. Often this is because eggs are the source of the next generation of chickens; sometimes it is because of superstition. Further, eggs do not keep well because most are fertile and, exposed to constant tropical heat, undergo rapid embryo development.

Crop Damage

It is often necessary to confine the birds to protect young crops or vegetable gardens.

RESEARCH AND CONSERVATION NEEDS

Unlike the situation with small cattle, goats, sheep, and pigs, there are few named and recognized breeds of Third World chickens. Yet, nearly every country has at least one kind of village chicken. These have survived there for centuries and are

highly adapted to local conditions. In village projects, these unnamed chickens deserve priority attention before other types are sought from elsewhere.

Generally speaking, improving the production of scavenging poultry does not require sophisticated research. Instead, simple precautions are sufficient. These are discussed below.

Disease Control

At a national or regional level, the initial approach to increasing chicken production in tropical areas should be disease control. There are several outstanding instances of success in this endeavor. For example, the spectacular rise of poultry production in Singapore (from 250,000 birds in 1949 to 20 million in 1957) followed the control of Ranikhet disease. Village flock-health programs, carried out regularly by visiting veterinarians ("barefoot veterinarians"), might be the answer to some of the routine health problems. Today, a prime target should be Newcastle disease, for which there are good chances for success (see page 76).

Management

The first step in chicken production at the farm level is improved management. With more care and attention, mortality can be greatly reduced. Because incubating and brooding hens must spend the night on the ground, they are extremely vulnerable. Even modest predator controls can be highly beneficial. Building crude and inexpensive nest boxes and constructing a simple holding area around them can substantially raise production by ensuring that more chicks survive.

THE CHICKEN'S WILD ANCESTOR

Although little known to most people, the red junglefowl has contributed more to every nation than any other wild bird. It is the ancestor of the chicken.

Given its descendants importance worldwide, the neglect of this bird is baffling. If the cow's wild ancestor, the aurochs, had not become extinct in the 1600s, it would now be worth millions of dollars as the ultimate source of cattle genetic diversity. Yet the world's chicken industry remains virtually unaware of the origin of its source of livelihood.

Like the aurochs, the red junglefowl has a wealth of wild genes, and it deserves more recognition and protection. For one thing the modern chicken - selectively bred in the temperate zone - is highly susceptible to heat and humidity; the junglefowl, on the other hand, is not. It inhabits the warmest and most humid parts of Asia: Sri Lanka, India, Burma, Thailand, and most of Southeast Asia. It may also be resistant to various chicken diseases and pests.

This is not a rare species. Throughout the wide crescent stretching from Pakistan to Indonesia, junglefowls are still seen in the wild, especially in forest clearings and lowland scrub. Although they are a prized bag for hunters, they survive by fast running and agile flying. They are sometimes sold in village markets, but can easily be mistaken for domesticated chickens, which in this region are often very similar. The wild junglefowl, however, has feathered legs, a down-curving tail, and an overall scragginess.

Junglefowls should be under intensive study. They are easy to rear in captivity and

do well in pens, even small ones, as long as they are sheltered from rain and wind. One drawback is their craze for scratching unless provided plenty of space they promptly tear up all grass and dirt. Another is that junglecocks are violent fighters and must be kept apart. (Cockfighting is probably a major reason why they were initially selected, and thus their aggressiveness is perhaps the reason we have the chicken today.)

These highly adaptable creatures live in a variety of habitats, from sea level to 2,000 m. Most, however, are found in and around damp forests, secondary growth, dry scrub, bamboo groves, and small woods near farms and villages. They are amazingly clever at evading capture and thrive wherever there is some cover.

Other junglefowl species might also provide useful poultry. They, too, can be raised in captivity with comparative ease, as long as the cocks are kept apart. Perhaps they might be tamed with imprinting and could prove useful as domestic fowl, especially in marginal habitats. They are everywhere considered culinary luxuries and their meat commands premium prices. Moreover, several have colorful feathers, giving them additional commercial value. These other species are:

- La Fayette's Junglefowl (Gallus lafayettei). Avery attractive bird of Sri Lanka, it is little known in captivity, and only in the United States are there any number in captivity.

- Gray or Sonnerat's Junglefowl (Gallus sonnerati). A native of India, this colorful bird produces feathers that are used in tying the most prized trout and salmon

flies. Demand is so great that certain populations have declined, and since 1968 India has banned all export of birds or feathers. Nonetheless, there are several hundred in captivity in various countries.

- Green Junglefowl (Gallus varius). This is yet another striking bird. The cock has metallic, greenish-black feathering set off by a comb that merges from brilliant green at the base to bright purple and red at the top. Native to Java, Bali, and the neighboring Indonesian islands as far out as Timor, it is found particularly near rice paddies and rocky coasts. This species, too, can be raised without great difficulty, and there are at least 90 in captivity in various parts of the world.

Nutrition

Improving poultry nutrition is also of prime importance. There are no quantitative data on the quality of a scavenging chicken's diet. Surveys are badly needed so that appropriate, low-cost supplements can be devised.

Chances are that the diet for chicks of scavenging poultry is almost always deficient in available energy. Minimal supplementation in the form of cereals or energy-rich by-products can greatly improve both egg and meat production. However, caution must always be exercised and the supplements given only to chicks. Overfed adults will give up scavenging and stay around the owner's house, without really producing much more meat or eggs.

Genetic Improvement

Although it seems attractive to replace the scrawny village chicken with bigger,

faster-growing imported breeds, it is a process fraught with difficulty. Exotic breeds lack the ability to tolerate the rigors of mismanagement and environmental stress. Many cannot avoid predators, as a result either of being overweight or of having a poor conformation for flight. The local birds, however, probably have a genetic potential that is much higher than can be expressed in the constraining environment. Thus, the environmental constraints should be tackled first.

However, the village birds may have a feed-conversion efficiency that is far less than ideal because they are adapted to a scavenging existence. Modern breeds imported into Ghana, for instance, showed a feed-conversion efficiency of less that 3.5:1 (weight of food eaten: growth and eggs), but the local birds had efficiencies of 11:1.4

Conservation

The need for preserving genetic variability is greater in poultry, especially in chickens, than in any other form of domestic animal. North America, for instance, which years ago had 50 or more common breeds, now relies on only 2 for meat production, and the others have been largely lost. Conservation of germplasm has become a matter of serious concern, and the saving of rare breeds in domestic fowl should not be delayed.

THE SOUTH AMERICAN CHICKEN

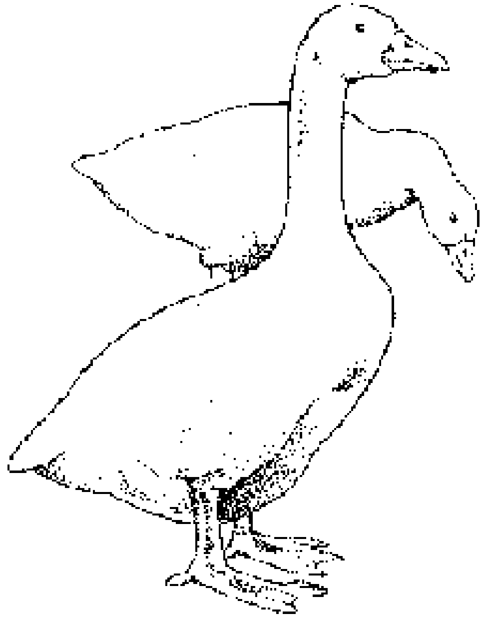
Early European explorers of South America were surprised to discover an abundance of unusual chickens that laid colored eggs and had feathers resembling earrings on the side of the head. While the origin of this bird - commonly called

the araucanian chicken and classified as Gallus inauris - is debatable, scientists generally agree that it is pre-Columbian. There is archeological evidence that this bird is native to the Americas. It is reported to have occurred in Chile, Ecuador, Bolivia, Costa Rica, Peru, and Easter Island. It still occurs in the wild in southern Chile and on Easter Island.

The araucanian has been called the "Easter-egg chicken" because it lays light green, light blue, and olive colored eggs. It lays well and has a delicious meat. In areas such as southern Chile the eggs are preferred over those of normal chickens because of their flavor and dark yellow yolk. This unusual bird has a high degree of variability; however, specimens of similar genetic background have been grouped to create "breeds" such as the White Araucanian, Black Araucanian, and Barred Araucanian. These are homozygotes and breed true.

The araucanian has been the subject of much public interest,. clubs dedicated to its preservation have been formed in the United States, Great Britain, and Chile. Its possible exploitation as a backyard microlivestock deserves serious consideration.

6 Ducks



FIGURE

Domestic ducks (Anas platyrhynchos)1 are well known, but still have much unrealized promise for subsistence-level production. Although a major resource of Asia, where there is approximately one duck per 20 inhabitants, they are not so intensively used elsewhere. On a worldwide basis, for instance, they are of minor importance compared with chickens.

This is unfortunate because ducks are easy to keep, adapt readily to a wide range of conditions (including small-farm culture), and require little investment. They are also easily managed under village conditions, particularly if a waterway is nearby, and appear to be more resistant to diseases and more adept at foraging than chickens.

Moreover, the products from ducks are in constant demand. Some breeds yield

more eggs than the domestic chicken. And duck meat always sells at premium. A few recently created breeds (notably some in Taiwan) have much lower levels of fat than the traditional farm duck. This development could open up vast new markets for duck meat, especially in wealthy countries, where consumers are both concerned over fat in their diet and eager for alternatives to chicken.

Ducks are also efficient at converting waste resources - insects, weeds, aquatic plants, and fallen seeds, for instance - into meat and eggs. Indeed, they are among the most efficient of all food producers. Raised in confinement, ducks can convert 2.4-2.6 kg of concentrated feed into I kg of weight gain. The only domestic animal that has better feed conversion is the broiler chicken.

Raised as village birds and allowed to forage for themselves, ducks become less productive but become even more cost effective because much of the food they scavenge has no monetary value.

AREA OF POTENTIAL USE

Worldwide.

APPEARANCE AND SIZE

Several distinctive types have been developed in various regions. Most have lost the ability to fly any distance, but they retain a characteristic boatlike posture and a labored, waddling walk. The Indian Runner, however, has an almost erect stance that permits it to walk and run with apparent ease.

Domestic ducks range in body size from the diminutive Call, weighing less than I

kg, to the largest meat strains (Pekin, Rouen, and Aylesbury, for example) weighing as much as 4.5 kg. For intensive conditions, the Pekin is the most popular meat breed around the world. In confinement it grows rapidly - weighing 2.5-3 kg at a market age of 78 weeks. In addition, it is hardy, does not fly, lays well, and produces good quality (but somewhat fatty) meat.

The Khaki Campbell breed is an outstanding egg producer, some individuals laying more than 300 eggs per bird per year.

The Taiwan Tsaiya (layer duck) is also a particularly efficient breed. It weighs 1.2 kg at maturity, starts laying at 120-140 days, and can produce 260-290 eggs a year. Its small body size, large egg weight, and phenomenal egg production make Brown Tsaiya the main breed for egg consumption in Taiwan. More than 2.5 million Brown Tsaiya ducks are raised annually for egg production.2

DISTRIBUTION

The domestic duck is distributed throughout the world; however, its greatest economic importance is in Southeast Asia, particularly in the wetland-rice areas. For example, about 28 percent of Taiwan's poultry are- ducks. In parts of Asia, some domestic flocks have as many as 20,000 birds. One farm near Kuala Lumpur, Malaysia, rears 40,000 ducks.

STATUS

Although ducks are abundant, some Western breeds are becoming rare. Indigenous types are little known outside their home countries and have received little study, so their status is uncertain.

HABITAT AND ENVIRONMENT

These adaptable creatures thrive in hot, humid climates. However, during torrid weather they must have access to shade, drinking water, and bathing water.

Ducks are well adapted to rivers, canals, lakes, ponds, marshes, and other aquatic locations. Moreover, they can be raised successfully in estuarine areas. Most ocean bays and inlets teem with plant and animal life that ducks relish, but (unlike wild sea ducks) domestic breeds have a low physiological tolerance for salt and must be supplied with fresh drinking water.

BIOLOGY

Ducks search for food underwater, sieve organic matter from mud, root out morsels underground, and sometimes catch insects in the air. Their natural diet is normally about 90 percent vegetable matter (seeds, berries, fruits, nuts, bulbs, roots, succulent leaves, and grasses) and 10 percent animal matter (insects, snails, slugs, leeches, worms, eels, crustacea, and an occasional small fish or tadpole). They have little ability to utilize dietary fiber. Although they eat considerable quantities of tender grass, they are not true grazers (like geese), and don't eat coarse grasses and weeds at all. Sand and gravel is swallowed to serve as "grindstones" in the gizzard.

When protected from accidents and predation, ducks live a surprisingly long time. It is not unusual for one to continue reproducing for up to 8 years, and there are reports of exceptional birds living more than 20 years.

Despite large differences in size, color, and appearance, all domestic breeds

interbreed freely. Eggs normally take 28 days to incubate, brooding and rearing is performed solely by the female.

Depending on breed, a female may reach sexual maturity at about 20 weeks of age. Most begin laying at 20-26 weeks, but the best egg- laying varieties come into production at 16-18 weeks and lay profitably for 2 years.

BEHAVIOR

It is generally well known that ducks are shy, nervous, and seldom aggressive towards each other or humans. Skilled and enthusiastic swimmers from the day they hatch, they spend many hours each day bathing and frolicking in any available water. However, most breeds can be raised successfully without swimming water.

Although wild ducks normally pair off, domestic drakes will mate indiscriminately with any females in a flock. In intensively raised flocks, I male to 6 females, and in village flocks, 1 male for up to 25 females, results in good fertility.

Most domestic ducks, particularly the egg-laying strains, have little instinct to brood. If not confined, they will lay eggs wherever they happen to be - occasionally even while swimming. To facilitate egg collection, some keepers confine ducks until noon.

Native distribution of the mallard, ancestor of the domestic duck. The Rouen a major commercial duck of France · is almost identical in coloration to the wild mallard. From such birds—with their iridescent green heads, brown necks, and gray and green bodies · · white mutants were selected in medieval times. Today's big white breeds developed in this way.

Figure

USES

As a meat source, ducks have major advantages. Their growth rate is phenomenal during the first few weeks. (Acceptable market weights can be attained under intensive management with birds as young as 6-7 weeks of age.) Yet, even in older birds, the meat remains tender and palatable.

Eggs from many breeds are typically 20-35 percent larger than chicken eggs, weighing on average about 73 g. They are nutritious, have more fat and protein, and contain less water than hen's eggs. They are often used in cooking and make excellent custards and ice cream. Eggs incubated until just before the embryos form feathers produce a delicacy known as balut in the Philippines. Salted eggs are popular in China and Southeast Asia.

Feathers and down (an insulating undercoat of fine, fluffy feathers) are valuable

by-products. Down is particularly sought as a filler for pillows, comforters, and winter clothing.

Ducks have a special fondness for mosquito and beetle larvae, grasshoppers, snails, slugs, and crustaceans, and therefore are effective pest control agents. China, in particular, uses ducks to reduce pests in rice fields.3 Its farmers also keep ducks to clear fields of scattered grain, to clear rice paddy banks of burrowing crabs, and to clear aquatic weeds and algae out of small lakes, ponds, and canals. This not only improves the conditions for aquaculture and agriculture, it also fattens the ducks.

HUSBANDRY

In Southeast Asia, droving is a traditional form of duck husbandry, much as it was in medieval Europe. The birds are herded along slowly, foraging in fields or riverbanks as they march to market. The journey might cover hundreds of kilometers and take as long as six months.

This process, however, is generally declining, and most ducks are raised under farm conditions where they scavenge for much of their feed. Throughout Southeast Asia, ducks have been integrated with aquaculture.

Ducks can be raised on almost any kitchen wastes: vegetable trimmings, table scraps, garden leftovers, canning refuse, stale produce, and stale (but not moldy) baked goods. However, for top yields and quickest growth, protein-rich feeds are the key. Commercial duck farms rely on such things as fish scraps, grains, soybean meal, or coconut cake. Agricultural wastes such as sago chips, palm-kernel cake,

and palm-oil sludge are being used in Malaysia.4

Ducks have a very high requirement for niacin (a B vitamin). If chicken rations are used, a plentiful supply of fresh greens must be provided to avoid "cowboy legs," a symptom of niacin deficiency.

ADVANTAGES

Of all domestic animals, ducks are among the most versatile and useful and have multiple advantages, including:

- Withstanding poor conditions;

- Producing food efficiently;

- Utilizing foodstuffs that normally go unharvested;

- Helping to control pests; and

- Helping to fertilize the soil.

Also, they are readily herded (for instance, by children).

Excellent foragers, they usually can find all their own food, getting by on only a minimum of supplements, if any. Raising them requires little work, and they provide farmers with food or an income from the sale of eggs, meat, and down.

Ducks can grow faster than broiler chickens if they have adequate nutrients. Like

guinea fowl and geese, they are relatively resistant to disease. They also have a good tolerance to cold and, in most climates, don't need artificial heat.

DOMESTICATING NEW DUCKS

Many species of ducks adapt readily to captivity; it is surprising, therefore, that only the mallard and the muscovy have been domesticated so far. Several wild tropical species seem especially worth exploring for possible future use in Third World farms, Because of the year-round tropical warmth, their instinct to migrate is either absent or unpronounced, and the heavy layer of fat (a feature of temperate-climate ducks that consumers in many countries consider a drawback) is lacking. Moreover, because of uniform daylength, they are ready to breed at any time of the year. Candidates for domestication as tropical ducks include:

- Whistling ducks (Dendrocygna species). These large, colorful, gooselike birds are noted for their beautiful, cheerful whistle.* They are long-necked perching ducks that are found throughout the tropics. By and large, they are gregarious, sedentary, vegetarian, and less arboreal than the muscovy - all positive traits for a poultry species.

The black-bellied whistling duck (D. auturunalis) seems especially promising. It is common throughout tropical America (southwestern United States to northwestern Argentina) and is sometimes kept in semicaptivity. Occasionally, in the highlands of Guatemala, for instance, Indians sell young ones they have reared as pets. When hand reared, the birds can become very tame. ** They eat grain and other vegetation, require no swimming water, and will voluntarily use nest boxes. In the wild, they "dump" large numbers of eggs so that even if substantial

numbers were removed for artificial hatching, the wild populations should not be affected.

- Greater wood ducks (Cairina species). The muscovy (C. moschata) was domesticated by South American Indians long before Europeans arrived (see page 124). Its counterparts in the forests of Southeast Asia and tropical Africa are, however, untried as domesticates. The white-winged wood duck (C. scutulata) is found from eastern India to Java. Hartlaub's duck (C. hartlaubi) occurs in forests and wooded savannas from Sierra Leone to Zaire. Both are rare in captivity, but might well prove to be future tropical resources. Both are strikingly similar to muscovies in size and habits, being large, phlegmatic, sedentary, and omnivorous.

LIMITATIONS

Predators are the most important cause of losses in farm flocks. Ducks are almost incapable of defending themselves, and losses from dogs and poachers can be high. Locking them in at night both protects the birds and prevents eggs from being wastefully laid outside.

Ducks do suffer from some diseases, mainly those traceable to mismanagement such as poor diet, stagnant drinking water, moldy feed or bedding, or overcrowded and filthy conditions. Of all poultry, they are the most sensitive to aflatoxin, which usually comes from eating moldy feed. They are also susceptible to cholera (pasteurellosis) and botulism, either of which may wipe out entire flocks. Duck virus enteritis (duck plague) and duck virus hepatitis also can cause severe losses.

If not carefully managed, ducks can become pests to some crops, especially cereals.

As noted, ducks tend to be extremely poor mothers and can be helped by using broody chicken hens or female muscovies as surrogate mothers.

Major limitations to large-scale, intensive production are mud, smell, and noise.

Defeathering ducks is much more difficult than defeathering chickens because of an abundance of small pinfeathers and down feathers.

RESEARCH AND CONSERVATION NEEDS

These birds already function so well that no fundamental research needs to be done. Nonetheless, there are a number of topics that could improve their production.

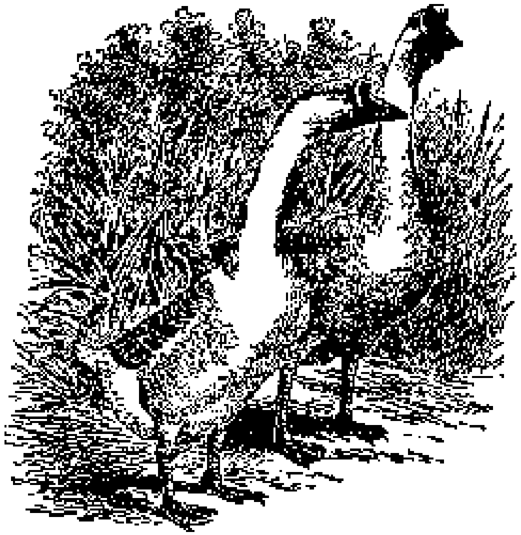
For example, different types of low-cost systems need to be explored and developed. These must be low-input systems since cash is a limiting factor for most subsistence farmers. One possibility is the integration of duck and fish farming.

A survey of all breeds is needed to determine their status and likelihood of extinction.

One need in countries that already have ducks is to encourage the consumption of duck meat. Indonesia, for instance, has 25 million egg-producing ducks, but little duck meat is consumed.

Research on economically significant diseases is needed.

7 Geese



Brown Chinese Geese

Although geese (Anser spp.) were one of the first domesticated animals, they have yet to receive the level of commercial or industrial exploitation of chickens or even ducks. Thus, their global potential is far greater than is generally recognized today.

Domestic geese are easily managed and well suited to small-farm production; they are among the fastest growing avian species commonly raised for meat, and they have immediate application in many developing countries.

These birds are especially appropriate for providing farmers a supplemental income. With little extra work they supply nutritious meat, huge eggs, and rich fat

for cooking, as well as soft down and feathers for bedding and clothing. Moreover, their strident voices sound the alarm when strangers or predators approach. They are especially well suited to aquatic areas and marshy lands and are completely at home in warm shallow waterways. Nevertheless, they can thrive away from water. In fact, wherever pasture is available geese readily adapt to captivity.

Geese are grazers, and can be raised almost exclusively on pasture. They are excellent foragers, and on succulent grass can find most or all of their own food. With their powerful bills they pull up grasses and underwater plants and probe soil and water for roots, bulbs, and aquatic animals. Their long necks make them adept at gleaning weeds from hard-to-reach places - such as fence rows, ditches, and swampy areas that baffle larger livestock. They will also feast on vegetable trimmings, garden and table leftovers, canning refuse, and stale baked goods. Like other poultry, they pick up shattered grains of rice, wheat, barley, and other crops, which can reduce the bothersome problem of weeds volunteering in subsequent years.

Geese are available worldwide. In most climates, they require little or no housing. Given reasonable care and protection from predators, mortality can be extremely low.

AREA OF POTENTIAL USE

Worldwide.

APPEARANCE AND SIZE

Domestic geese come in an assortment of colors, sizes, and shapes. There are two

main types, however. Descendants of the wild greylag goose (Anser anser) make up the domestic breeds common in North America and Europe, including the Embden, Toulouse, Pilgrim, American Buff, Pomeranian, Sebastopol, and Tufted Roman breeds. These are generally best suited to temperate climates. On the other hand, descendants of the wild "swan goose" (Anser cygnoides) make up the geese of Asia, including the Chinese and "African" types. These breeds seem better suited to hot climates.

In addition to these, many European and Asian countries have their own local breeds and types, and there are even several wild species that show some potential for captive production.

With their long legs and webbed toes, geese are equally at home walking or swimming. Avid walkers, they march long distances to find forage, but return home at dusk. Accomplished and graceful swimmers, geese are able to take to water soon after they hatch. Despite their large size, some domestic breeds - especially the leaner ones - have retained the ability to fly.

DISTRIBUTION

Geese are found worldwide, but goose farming is nationally important only in Asia and Central Europe.

STATUS

Domestic geese are not threatened, although much local variation among the breeds is being lost.

HABITAT AND ENVIRONMENT

Most geese adapt well to hot climates - as long as some shade is available. Their waterproof feathers help them adapt well to high rainfall regions. They also tolerate extreme cold. (For instance, in Canada, geese are wintered outdoors in subfreezing temperatures, with merely 'e simple shelter from wind.)

For tropical developing countries, the Chinese type, which is widely kept in Southeast Asia, is especially promising. Smaller than most geese (although ganders can weigh over 5 kg), they are the best layers, the most active foragers (making them economical and useful as weeders), the most alert and "talkative," and they produce the leanest meat. Some European breeds, such as Embden and Toulouse, have also been used in the tropics with notable success.

DOMESTICATING GEESE
(Temperate Zones)

Today's domestic geese are descended from two species: the greylag (Anser anser) and the swan goose (Anser cygnoides). These were domesticated in Europe and China, respectively. Their domestication occurred in ancient times, long before people knew about genetics, microorganisms, veterinary science, or behavior modifications such as imprinting. Today, armed with such knowledge, more geese may be amenable to domestication. Most of the 15 other wild species adapt to captivity. Compared to most birds, geese spend much time walking and swimming and are less inconvenienced by pinioning (removing the tip of the wing). Thus, they can be kept outdoors rather than in cages.

Both of the ancestors of today's domestic geese are native to the northern temperate zone. Two more wild species that might make useful domesticates are:

- Canada goose (Branta canadensis). North America. People feeding these birds in city parks and wildlife refuges are causing many local flocks to develop. These birds no longer migrate. They are increasing in numbers each year and are well on the way to de facto domestication.

- American swan goose (Coscoroba coscoroba). Southern South America. Although most closely allied to swans in shape and physiology, this bird resembles a muscovy (see page 124) in size and behavior. Its calm disposition, as well as its attractive red feet and bill that accent its white plumage, have made it much sought as an ornament for parks.

BIOLOGY

In its diet, the goose utilizes large quantities of tender forage. It can break down plant-cell walls and digest the contents. Although it has no crop for storing food, there is an enlargement at the end of the gullet that serves as a temporary storage organ. Sand and small gravel are swallowed to aid the gizzard in grinding hard seeds and fibrous grasses. Research has shown that geese can digest 15-20 percent of the fiber in their diet, which is 3-4 times the amount that other poultry species can digest.

The natural diet consists of grasses, seeds, roots, bulbs, berries, and fruits, normally supplemented with a little animal matter (mainly insects and snails) picked up incidentally. Most feeding takes place on land. They characteristically

feed for prolonged periods, even at night.

Females may lay for 10 years or more. It is generally believed that reproduction is best in the second year and that it remains good until the fifth year. Geese outlive other types of poultry; life spans of 1520 years are common.

The eggs incubate in 27-31 days. The incubation time is more variable than in most poultry species, perhaps because geese have not been subjected to the selection pressure that is imposed by artificial incubators.

BEHAVIOR

One of the most intelligent birds, the goose has a good memory and does not quickly forget people, animals, or situations that have frightened it. While personalities and habits vary among individual specimens, there are common behavioral patterns, such as the pecking order, that allow individuals to live peaceably together.

Unless conditions are crowded or there are too many males, geese normally live harmoniously both with themselves and with other creatures. The bond between male and female is strong. Changing mates is difficult, although most geese will eventually accept a new mate after a period of "mourning."

Geese nest on the ground and prefer the water's edge, but they adapt readily to man-made nesting boxes. The gander usually stands guard while the goose incubates the eggs. He then assists in rearing the goslings. Most geese become irritated if intruders approach their nest or goslings, and will even attack people and large dogs.

USES

As previously noted, these birds provide meat, eggs, fat, and down. The meat is lean, flavorful, and of outstanding quality. The fat accumulates between the skin and the flesh and can be rendered into a long-lasting oil. The eggs are large and taste much like chicken eggs. The "down" (the small, fluffy feathers that lie next to the body of adult birds) is the finest natural insulating material for clothing and bedding, and can fetch a premium price. Worldwide markets exist for both down and other goose feathers. In France, in particular, some geese are raised for their livers (foie gras).

Geese can control many types of aquatic weeds in shallow water as well as grass and some types of palatable broad-leaf weeds on the banks of lakes, ponds, and canals. They can also be used as ''lawn mowers" and "weeders" among cotton, fruit trees, and other crops (see sidebar).

Elongated necks not only allow geese to reach many different foods, they also help them keep a watchful eye on the surroundings. With their exceptional eyesight they can see great distances, and the position of the eyes gives them a wide field of vision. Geese are among the most alert of all animals, and strangers cannot calm them into silence. In the high Andes, in Southeast Asia, and in many other locations, they replace guard dogs. In Europe, they are used to guard whiskey warehouses and sensitive military installations.

HUSBANDRY

Methods of caring for adult geese vary according to climate, breed, and people's

experiences and needs. Overall, however, the birds cause little trouble and require little expense. They range freely without restriction, feeding themselves and returning home of their own accord. They have strong flocking instincts and can readily be herded from one area to another.

Like all young poultry, goslings are fragile. The highest mortality is caused by predators. Until the goslings are 6-10 weeks old, it is prudent to confine the parents and their young at night in a secure pen or building.

Geese are the only domestic fowl that can live and reproduce on a diet of grass. They cannot remain healthy on coarse dry fodder, but when grass is succulent they need little else other than drinking water. Many legumes also make excellent goose forage.

In the tropics, eggs can be laid year-round. The production seldom exceeds 40 eggs per year, although with feed supplement and simple management, the Chinese breed may yield more than 100 eggs. Geese go broody quickly. To break up broodiness, the goose can be confined for 4 6 days away from, but in sight of, the ganders.

Goslings grow rapidly and can reach market size as early as 10-12 weeks; most geese, however, are marketed at 20-30 weeks of age, when they may weigh from 5 to 7 kg, depending on type and breed. Some young birds (also called green or junior geese), force-fed for rapid growth, are marketed at 4-6 kg when they are 8-10 weeks old.

If fed a good diet to maximize growth and if slaughtered at, say, 10 weeks, the

Embden, Chinese, or African will have a carcass low in fat. However, the carcass normally has much more fat than other poultry.

Geese must have a constant supply of reasonably clean drinking water during daylight hours. Although swimming water is not necessary, it promotes cleaner and healthier birds because they find it easier to care for their plumage.

DOMESTICATING GEESE
(Tropics)

Geese of the tropics have seldom if ever been considered for domestication, but they might provide poultry of considerable value. Presumably they are more heat tolerant and lack the layers of subcutaneous fat (which the ancestors of today's geese needed for warmth in the Arctic). They might thus produce lean birds that would fetch premium prices because excessive fat is the major drawback of today's commercial geese. Examples of tropical species that might be domesticable are:

- Egyptian goose (AIopochen aegyptiacus). Found throughout the African tropics, this bird is already partly domesticated. However, it is bad tempered and quarrelsome and, so far, this has limited its utility. It has therefore been kept only under semidomestication, without intensive breeding.

- Nene (Branta sandvicensis). A native of the Hawaiian Islands, this is one of the most endangered species on earth. So few specimens are in existence that farming enterprises cannot now be envisaged. Yet, should this bird prove amenable and suitable, the possibility of an economic future could boost efforts to build up its

now meager populations.

- Bar-headed goose (Anser indicus). India and Central Asia. These smallish geese are handsome, dainty, and have a musical horn-like call. They have distinct black bars across the nape, which gives them their popular name. Hand-reared specimens breed well in captivity. Despite heavy hunting they are still abundant.

- Northern spur-winged goose (Plectropterus gambensis gambensis). Tropical Africa (Senegal to Zimbabwe). This large bird is a ground nester, but it has long bony spurs on the wings that enable it to easily protect its eggs and young from predators.

- Semipalmated (magpie) goose (Anseranas semipalmata). Australia and New Guinea. One of the most aberrant and primitive of all waterfowl, this long-legged sturdy-billed bird has only partially webbed feet. It perches high in trees and has a loud ungooselike whistling call.

THE WADDLING WORK FORCE

Because geese relish grasses and shun most broad-leafed plants, some enterprising U.S. farmers in the 1950s began using them to rid cotton fields of grassy weeds, which are difficult to kill with herbicides. The geese were put into the fields as soon as the crop came up. A brace of birds kept an acre of cotton weeded; a gaggle of 12 would gobble as many weeds as a hard-working man could clear with a hoe.

This method of clearing fields was so effective that by 1960 more than 175,000 geese honked their way across the carefully tended farmland, mainly in the

Southwest. Seven days a week, rain or shine, the feathered field hands slaved uncomplainingly from daybreak to dusk, even putting in overtime on moonlit nights. Many toiled so diligently that they worked themselves out of a job.

The geese cleared the fields more cheaply than hoe hands. They left the crop untouched and ate only the succulent young weeds. They did not damage crop roots (as hoes or tractors can), and they were safe and selective, unlike many herbicides. On top of all that they spread fertilizer for the farmer, and ultimately provided him meat for the market.

Eventually, farmers found that geese could be used to weed nearly all broad-leafed crops: asparagus, potatoes, berry fruits, tobacco, mint, grapes, beets, beans, hops, onions, and strawberries, for example. Geese were used in vineyards and fruit orchards to eat both weeds and the fallen fruits that could otherwise harbor damaging insects. They were employed in fields producing trees for the forest industry and flowers for florists shops. Some growers turned goslings loose in cornfields to consume the "suckers" (cone, after all, is a grass) as well as the grain left on the ground. This eliminated the problem of corn as a weed when different crops were later planted in those fields.

In the 1970s when cotton acreage dropped and herbicides selective for the troublesome grasses were developed, the use of geese declined. But today, some organic farmers are returning to the practice. From February to June in the Pacific Northwest, fields are resounding once more to the old-fashioned racket of White Chinese geese.

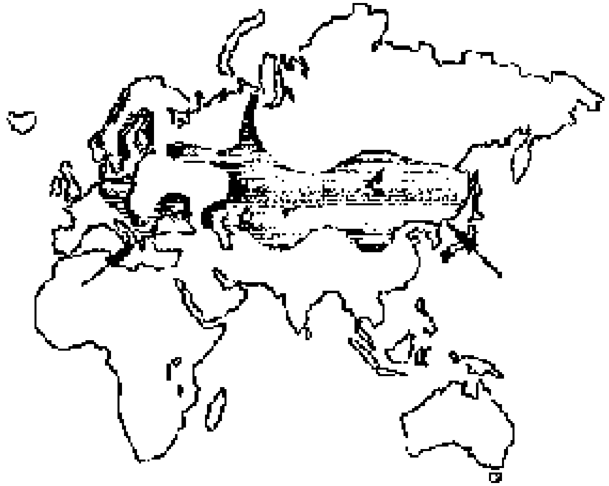
ADVANTAGES

Mature geese are independent creatures. When kept in small flocks and allowed to roam the farmyard or field, they require less attention than any other domestic bird with the possible exception of guinea fowl. In areas where grass is green for much of the year, they can be raised on less grain or concentrated feed than any other domestic fowl.

Durability is one of their most attractive features. Along with ducks, geese seem to be the most resistant of all poultry to disease, parasites, and cold or wet weather. They also do well in hot climates as long as drinking water and deep shade are available.

Growth is not only rapid, it is also efficient. If managed properly, goslings can produce I kg of body weight for every 2.25-3.5 kg of concentrated feed consumed.

Geese are not usually thought of as prolific layers. However, as noted, some strains of the Chinese breed will yield well over 100 eggs per goose per year. At 140-170 g per egg, that compares favorably with the output of laying chickens.



The native origins of geese. The arrows show the probable places where the two main types were domesticated.

figure

LIMITATIONS

These birds are messy and their loud trumpeting is often irritating. However, unless they have been teased or mistreated or if they are nesting or brooding young, they are not aggressive. But kilo for kilo, they are stronger than most animals, and a harassed or angry adult can express its displeasure effectively with powerful bill and pounding wings.

Excessive concentrations of geese on ponds or along creeks encourages unsanitary conditions, muddies water, hastens bank erosion, and destroys plant life. Where sanitation is poor, salmonellosis can devastate geese and be transmitted, via meat and eggs, to humans. Coccidiosis and gizzard worm are other infections.

Defeathering geese is more difficult than plucking chickens because there are two coats (feathers and down) to remove.

In some situations, geese may need a diet supplement (such as grain) if they are grazing vegetation exclusively. A balance must be struck: too much supplement and they will quit foraging and become too fat; too little and they grow slowly and may suffer malnutrition.

Geese are not fully mature until two years of age. Their overall reproductive rate, therefore, is lower than that of other poultry.

RESEARCH AND CONSERVATION NEEDS

Poultry researchers worldwide should begin studies to clarify the role that geese could play in helping to feed Third World nations. Studies might include:

- Management practices for tropical areas;

- Breeding and management for increased egg production;

- Incubation techniques;

- Nutrition supplementation (for example, vitamins, minerals, energy, specific amino acids) needed by grazing geese;

- Physiology of digestion and reproduction;

- Clarifying the inheritance of various traits;

- Genetic selection for specific meat, eggs, growth factors, or disease resistance;

- Comparative studies of the relative efficiency (especially of feed utilization) of the various types and breeds for specific climates in underdeveloped countries;

- Weeding tropical crops with geese; and

- Studying diseases and cross-infection with other birds.

8 Guinea Fowl

FIGURE

For Third World villages, the guinea fowl (Numida meleagris) could become much more valuable than it is today. The bird thrives under semi-intensive conditions, forages well, and requires little attention. It retains many of its wild ancestor's

survival characteristics: it grows, reproduces, and yields well in both cool and hot conditions; it is relatively disease free; it requires little water or attention; it is almost as easily raised as chickens and turkeys; and it is a most useful all-round farm bird.

The guinea fowl's potential to increase meat production among hungry countries should be given greater recognition. The birds are widely known in Africa and occur in a few areas of Asia, but they show promise for use throughout all of Asia and Latin America and for increased use in Africa itself. Strains newly created for egg and meat production in Europe - notably in France - show excellent characteristics for industrial-scale production. Also, many semidomestic types in Africa deserve increased scientific assessment as scavenger birds.

Meat from domestic guinea fowl is dark and delicate, the flavor resembling that of game birds. It is a special delicacy, served in some of the world's finest restaurants. Several European countries eat vast amounts. Annual consumption in France, for example, is about 0.8 kg per capita.'

Guinea fowl also produce substantial numbers of eggs. In Africa, these are often sold hard-boiled in local markets. In the Soviet Union, they are produced in large commercial operations. In France, guinea fowl strains have been developed that not only grow quickly but lay as many as 190 eggs a year.

Outside Europe, virtually all guinea fowl are raised as free-ranging birds. These find most of their feed by scratching around villages and farmyards. Their cost of production is small, and they yield food for subsistence farmers. In Europe, on the other hand, most are raised in confinement, with artificial insemination, artificial

lighting, and special feeding. In the main, this is to produce meat for luxury markets.

Guinea fowl production is beginning to increase all over the world. During the last 20 years, for example, many of Europe's chicken farmers and breeders, wishing to diversify, have switched to this bird. The United States is now studying ways to establish industrial production, and both Japan and Australia are increasing their flocks. Nonetheless, there is still a vast untapped future for this bird.

AREA OF POTENTIAL USE

Worldwide. This species is robust and resilient and adapts to many climates.

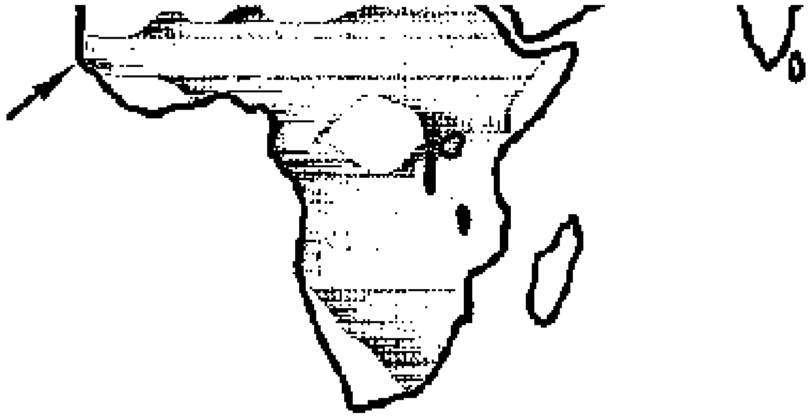
APPEARANCE AND SIZE

Guinea fowl are somewhat larger than average scavenger-type chickens: adults weigh up to 2.5 kilograms. They have dark-grey feathers with small white spots. Their heads are bare with a bony ridge (helmet) on top, which makes them look something like vultures. The short tail feathers usually slope downwards.

The chicks, known as "keels," resemble young quail. They are brown striped with red beaks and legs. The sexes are indistinguishable until eight weeks of age. After that, the males' larger helmets and wattles and the cries of the different sexes can be identified. Both sexes give a one-syllable shriek, but females also have a two-syllable call.

Like the chicken, the guinea fowl is a gallinaceous species and possesses the characteristic sternum with posterior notches and a raised "thumb."

Among domestic types are pearl, white, royal purple, and lavender. Pearl is the most common, and is probably the type first developed from the wild West African birds. Its handsome feathers are often used for ornamental purposes. The white is entirely white from the time of hatching and has a lighter skin.



The guinea fowl's native habitat. The arrow shows the probable place where today's main breed originated.

figure

DISTRIBUTION

Europe dominates industrial production. France, Italy, the Soviet Union, and Hungary all raise millions of guinea fowl under intensive conditions, just as they raise chickens. Elsewhere, guinea fowl have become established as a semidomesticated species on small family farms. Native flocks are found about villages and homes in parts of East and West Africa, and free-ranging flocks can be seen in many parts of India, notably Punjab, Uttar Pradesh, Assam, and Madhya Pradesh. During the slavery era, they were introduced from Africa to the Americas to be used for food. In Jamaica, Central America, and Malaysia, the birds have reverted to the wild state and are treated as game.

STATUS

Guinea fowl are abundant; in most places even wild populations are not threatened.

HABITAT AND ENVIRONMENT

Guinea fowl are native to the grasslands and woodlands of most of Africa south of the Sahara where they occupy all habitats except dense forests and treeless deserts. Being native also to temperate South Africa, they appear to have an inherent adaptability to both heat and cold. However, in cool climates, regardless of daylength, they will not begin egg production until temperatures exceed 15°C.

BIOLOGY

Guinea fowl accept many foods: grains, leaves, ant eggs (for which they will tear anthills open), and even carrion.

Normally, they lay their first egg at about 18 weeks of age. Unlike many wild birds, which produce a single clutch a year, guinea hens lay continuously until adverse weather sets in.2 Free-range "domestic" guinea hens lay up to 60 eggs a season. And well-managed birds under intensive management lay close to 200. The eggs weigh approximately 40 g. Shells are stronger than those of chickens and are usually brown, but can be white or tinted.

The guinea hen goes broody after laying, which can be overcome by removing most of the eggs. A clutch of 15-20 is common. The incubation period is 27 days.

BEHAVIOR

These birds never become "tame," but neither do they leave the premises. Although they stray farther than chickens do, they always return. They like to hide their eggs in a bushy corner, often in hollows scratched in the ground. They can fly, although even in the wild they do not fly far. They prefer to roost on high branches and (unless pinioned) can be hard to catch during the day.

Although wild guinea fowl live in groups, they are monogamous by nature and tend to bond in pairs. However, in domestication a single male may serve four or more females.

USES

As noted, guinea fowl are valuable sources of both meat and eggs. They can also be used to control insect pests on vegetable crops.3

Guinea fowl are good "watch animals"; they have fantastic eyesight, a harsh cry, and will shriek at the slightest provocation. Their agitation on sighting dogs, foxes, hawks, or other predators have saved the lives of many a chicken, duck, and turkey. They are brave and will attack even large animals that threaten them.4

HUSBANDRY

Guinea fowl can be kept in confinement using the methods for raising battery chickens. In this system, breeding stock are housed in cages and artificially inseminated. It gives the best egg production and fertility but requires housing, equipment, and skilled labor.

These birds can also be kept in a semidomestic state in and around the farmyard. In such cases they are penned until they are 12 weeks old. Unaccustomed to foraging for natural food, they constantly return to their artificial food supply. Eventually, however, they learn to subsist by scavenging.

The birds have been called "the worst parents in the world," and are almost incapable of looking after their keets.5 Because the females are such indifferent mothers, the eggs are best hatched in incubators or under other birds, to avoid the keets' being lost by their natural mothers. In many African countries, eggs are hatched under chickens.

Keets are often kept indoors until they are 3-4 weeks old to protect them from predators and wet weather. Sexual maturity can be delayed to as late as 32 weeks of age by holding the birds in windowless housing and controlling the lighting. This improves egg size and hatchability and reduces early mortality.

GUINEA FOWL AND THE ANCIENTS

The earliest reference to guinea fowl can be found in murals in the Pyramid of Wenis at Saqqara in Egypt, painted about 2400 B.C. Aviaries were quite fashionable at the time, and wealthy landowners maintained guinea fowl within their walled gardens. A thousand years later, by the time of Queen Hatshepsut (about 1475 B.C.), the junglefowl (the ancestor of the chicken) had arrived, and from then on it was raised on a substantial scale. Records of this period refer to "walk-in" incubators, constructed of mud bricks and heated by cameldung fires. The largest could hold up to 90,000 eggs (mainly from junglefowl but some from guinea fowl) and hatching rates of up to 70 percent were claimed.

By 400 B.C., guinea fowl were well established on farms in Greece. Later, they rose to importance in ancient Rome. Pliny the elder (in his Natural History, published 77 A.D.) stated that they were the last bird to be added to the Roman menu and that they were in great demand, both eggs and flesh being considered great delicacies. The emperor Caligula offered them as sacrifices to himself when he assumed the title of deity.

The guinea fowl then died out in Europe but was reintroduced by the Portuguese navigators returning from their African explorations in the late 1400s. They gave it the name pintada or "painted chicken" and this changed to pintade in French, while the name "Guinea fowl" (fowl from Africa) stayed in English, and gallina de Guinea in Spanish. Coincidentally, guinea fowl and turkeys were both introduced to England between 1530 and 1550, and the English, smitten with the original French misnomers, were left sorting out "Ginny birds" and "Turkey birds" for the remainder of the century. Both birds were adopted with great enthusiasm, and within 150 years they had utterly displaced the peafowl and swan as the major table birds for festive occasions.
Adapted from R.H.H. Belshaw, 1985 Guinea Fowl of the World

ADVANTAGES

Compared with the farmyard chicken the guinea fowl's advantages are:

- Low production costs;

- Premium quality meat;

- Greater capacity to utilize green feeds;

- Better ability to scavenge for insects and grains;

- Better ability to protect itself against predators; and

- Better resistance to common poultry parasites and diseases (for example, Newcastle disease and fowlpox).

Surprisingly, this semidomestic bird, which has been farmed for centuries, retains the characteristics (feather morphology, hardiness, social behavior) of its wild ancestor - even when subjected to the most modern intensive-rearing methods employing battery cages and artificial insemination. Thus, it thrives under semicaptive conditions and needs little special care. The birds forage well for themselves and do not require much attention; their meat is tasty and they produce substantial numbers of eggs. Unlike chickens, they don't scratch to get insects out of the soil, so they are less destructive to the garden.

LIMITATIONS

In backyard production the guinea fowl is supreme, but when produced intensively it costs more to raise than chickens. In Europe, for instance, day-old keets cost about twice as much as day-old broiler chicks. (The major reason is that guinea fowl produce fewer hatching eggs and require a longer feeding period.) Guinea fowl are also more expensive to feed. Their feed conversion (for meat production at the marketing age) is about 3.3-3.6 as compared with a broiler's feed conversion of 1.8-1.9. Moreover, guinea fowl take about twice as long to reach marketable size: they are marketed for meat at age 12-14 weeks, compared with 7-8 weeks for the broilers. Therefore, the selling price of guinea

fowl in the Western world is up to twice that of broilers.

Guinea fowl are nervous and stupid. They can be difficult to catch' and when panicking they can easily suffocate their keets.

They are susceptible to some of the common diseases of chickens and turkeys. Salmonella is the most prevalent, but others are pullorum disease, staphylococcus, and Marek's disease.

THE GUINEA FOWL'S WILD COUSINS

The domesticated guinea fowl is descended from just one subspecies of the family's seven known species and numerous subspecies. Some of the others may also have promise as poultry. They, too, generally occur in flocks in bushy grasslands and open forests in Africa. All feed on vegetable matter such as seeds, berries, and tender shoots, and on invertebrates such as slugs. They rarely fly except to roost. They acclimatize well are easy to maintain in captivity, and can survive long periods away from water.** Their disposition is tame and nonaggressive, and they mix well with other birds.

Wild subspecies closely related to the domestic guinea fowl that might make future poultry in their own right include the following:

- Gray-breasted guinea fowl (Numida meleagris galeata). This subspecies is the principal ancestor of domestic guinea fowls. It is found throughout West Africa and probably has many valuable genetic traits. There is much variation in the size and other characteristics among the various individuals. People along the Gambia, Volta, and Niger rivers have long traditions of breeding these birds.

- Tufted guinea fowl (Numida meleagris meleagris). This subspecies is quite large and has black plumage thickly spotted with white dots. It is the probable ancestor of the birds reared in ancient Egypt and in the Roman empire (see page 120). Hill farmers in the southern Sudan sometimes breed them in captivity.

- Mitred guinea fowl (Numida meleagris mitrata). Probably the most popular game bird in East Africa, this type has a bright blue-green head and red wattles. It was once a common sight in the wild but it has now been decimated by overhunting. It is now most numerous in the Masai lands of Kenya and Tanzania. It has been kept in a semidomesticated form in Zanzibar for several centuries. Zoos and aviaries around the world have imported it, and it has bred well for them.

Wild guinea fowl that are different species from the domestic one but that are still worth considering as potential poultry include the following:

- Black guinea fowl (Phasidus niger or Agelastes niger). This bird of the tropical rainforests of West and Central Africa is the size of a small chicken. It has sooty black plumage, a naked head, and a pink or yellow neck. It is seldom hunted because the meat tastes dreadful but this is probably because of a particularly pungent fungus they eat in the forest. Raised on fungus-free forages, these birds are probably very palatable.

- Crested guinea hen (Guttera spp.). Three species. These strange-looking birds have a thick mop of inky black feathers above their black, naked faces. Widely distributed in the thickly forested areas of sub-Saharan Africa. Unlike the other species, they prefer the rainforest. They have a musical trumpeting call. At least one species has bred well in Europe. For example, a flourishing colony has been

established in the Walsrode Bird Park in Germany.

- Vulturine guinea fowl (Acryllium vulturinum). The largest of all guinea fowl, this species is found in parts of Ethiopia, Somalia, and East Africa. One of the most striking looking of all birds, its head is bare and blue, its body black with white spots, and its breast bears long bright cobalt-blue patches on either side. This has been reared as an aviary bird in both Europe and America and might make a useful domesticate.

RESEARCH AND CONSERVATION NEEDS

Agencies involved in international economic development should undertake guinea fowl assessment trials, evaluations, and coordinated introductions to stimulate programs for small farmers and for industries in dozens of countries.

Breeders have been working to improve guinea fowl only since the 1950s. There is a need for more information on growth rate, health, egg production, feed conversion, body weight, carcass yield, laying intensity, fertility, hatchability, and egg weight - especially under free-ranging conditions.

Husbandry research should also be directed towards feeds and feeding systems for growing and breeding stock. Other efforts are needed to increase the hatchability of eggs under natural conditions (under guinea hens or surrogate mothers), and to identify the best lighting regimes (both sexual maturity and rate of lay are influenced by changes in daylength).

The guinea fowl that has become an important domesticated bird throughout the civilized world is descended from just one of seven known species in the family.

These birds generally occur in flocks in bushy grasslands and open forest in Africa and Madagascar, and some of the others may also have promise as poultry (see sidebar opposite).

9 Muscovy

FIGURE

The muscovy (Cairina moschata), a unique ducklike species of the South American rainforest, belongs to a small group of waterfowl that perch in trees. In poultry science, however, it is normally grouped with domestic ducks for lack of a better classification.

Except in France, Italy and Taiwan muscovies have received little modern research. But their promise can be judged from the fact that they account for 50 percent of the duck meat consumed in France - about 60,000 tons per year - and they are often consumed in Italy and Taiwan as well.

For Third World subsistence farming, muscovies have excellent possibilities. There is probably no better choice for a meat bird that requires minimal care and feed.

Tame, quiet, and able to forage for much of their keep, they are inherently hardy, vigorous, and robust. They have heavily fleshed breasts and are highly prized for their meat, which is dark, more flavorful, and less fatty than that of common ducks. An average muscovy gives more meat than a chicken of the same age, and it also survives hot, wet environments better. In addition, muscovies are better parents than the domestic duck. Females are probably the best natural mothers of any poultry species, as measured by their success at incubating their eggs and caring for their young.

All in all, this bird deserves more attention than it has received so far in Third World livestock projects. Dispersed around the warm and hot regions of the world, muscovies already exist in small numbers in backyards and villages, much like the domestic chicken in previous centuries. Despite a lack of research, the present unimproved stocks are already impressive meat yielders. Used more widely and more intensively, they could contribute much to poor people's meat supplies.

Crossing the muscovy with the common duck produces a hybrid that combines many of the advantages of both. This cross, known as "mulard," or "mule duck" in English, is raised in France for its liver and meat and is produced in quantity in Taiwan (see sidebar, page 132). It, too, has a major future role.

AREA OF POTENTIAL USE

Muscovies are suitable for use almost anywhere that chickens can be kept. Moreover, their tropical ancestry and inherent robustness give them an advantage in hot and humid climates.

APPEARANCE AND SIZE

Although a muscovy somewhat resembles a goose, it is one of the greater wood ducks of tropical South America. It was domesticated in pre-Columbian times, most likely in the rainforests of Colombia. Related wild types, looking very much like the muscovy, still occur in South American wetlands, particularly mangrove swamps.

Males have mature live weights of 5 kg and females about 2.5 kg. Both have broad and rounded wings. The adults have patches of bare skin around the eyes, rather than feathers. Much of this is covered in "caruncles," which superficially resemble warty outgrowths. The feet have sharp claws. Both sexes raise a crest of feathers when alarmed.

There is much color variation among the various muscovy populations including types that are called white, colored, black, blue, chocolate, silver, buff, and pied.2 The most common types (they are not considered breeds) are the white and the colored. The white produces a cleaner looking carcass, but the colored is the most popular meat type in France. Its plumage is an iridescent greenish black, except for white forewings.

DISTRIBUTION

The native range of the muscovy's probable wild ancestor covers much of Central America and northern South America. The domestic form also occurs over most of Latin America - from southern Chile to the northern limits of traditional culture in lowland Mexico - including the Caribbean, where it was present shortly after

Columbus landed.3 The birds can be observed among the domestic fowl in the high Andes, for example, and are feral in southern coastal areas of the United States.

Carried across the Atlantic, probably in the early 1500s, the domesticated muscovy spread quickly in Europe, and thence to North America, Asia, Africa, and Oceania. Today, it finds favor with the food-loving French as "canard de Barbarie," and France has the greatest concentration of muscovies in Europe.

Down the centuries the muscovy became popular in tropical Asia (especially the Philippines and Indonesia) and in China and Taiwan. Throughout Indonesia (where it is known as "entok") it is popular with villagers for incubating eggs from ducks, geese, and chickens. It is now spreading into Oceania, and has recently gained particular favor in the Solomon Islands.

Muscovies are also known in Africa and can be found in many villages, especially in West Africa.

STATUS

Not endangered.

HABITAT AND ENVIRONMENT

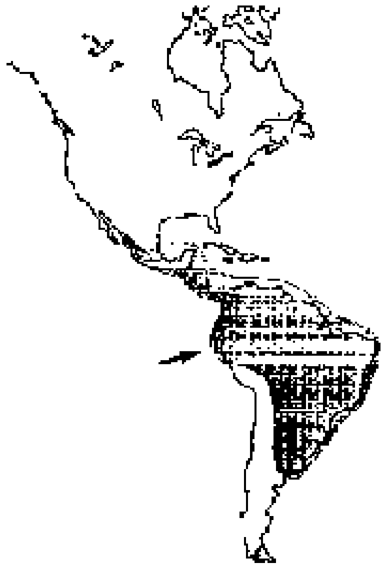
Wild muscovies occur mainly along tropical jungle streams, but domestic muscovies are found in many environments from the heat of Central America to the cold of Central Europe. They also tolerate dry conditions, but they thrive best where climates are both hot and wet.

BIOLOGY

Muscovies utilize high-fiber feeds better than chickens and common ducks, and eat larger quantities of grass. They also consume other green vegetation and readily snap up any insects they can find. If quality forage is available, only a small daily ration of grain or pellets is required for them to reach peak production.

Muscovy females normally hatch and raise large broods efficiently. It is not unusual to see them with a dozen or more fragile ducklings in tow - many of them adopted from other species. They bravely protect their young and have been known to beat off cats, dogs, foxes, and other marauders.

Normally, muscovies are healthy and live and breed for many years. They suffer few diseases, especially when free ranging. However, they seem to be more susceptible to duck virus enteritis (duck plague) than common ducks.



The wild muscovy's natural range covers a vast area of tropical America. As a result, their domesticated descendants are well adapted to many conditions, including both tropical and temperate climates. The arrow indicates the area where this bird was probably first domesticated.

figure

BEHAVIOR

While appearing to be slow and lethargic, muscovies can be quick and agile when one tries to catch them. Females are strong fliers and readily clear a standard fence. Males frequently become so ponderous that they cannot get airborne without an elevated perch or the aid of a strong wind. Although they forage over a larger area than chickens, they generally neither decamp nor wander as far as common ducks.

Domesticated muscovies are either solitary or live together in small family groups, but sometimes in winter they flock together on bodies of water. They swim and dive well.

These birds seldom make loud noises. A drake's voice resembles a muffled "puff"; females are almost mute. However, both can hiss or make a soft sound not unlike that of sleigh bells.

The muscovy is polygamous (a young male will try to mate with almost any fowl, including chickens). Mating can occur on land or in water. Males are pugnacious and tolerate no opposition. Because of this, they do not do well in close confinement.

A BETTER FLY TRAP

The muscovy is a voracious omnivore that is particularly fond of insects. For years, some Canadian farmers have sworn that a few muscovies took care of all fly problems on their farms. In 1989, Ontario biologists Gordon Surgeoner and Barry Glofcheskie (see Research Contacts) decided to put this to the test.

Starting with laboratory trials, the entomologists first put a hungry five-week-old muscovy into a screened cage with 400 living houseflies. Within an hour it had eaten 326. Later, they placed four muscovies in separate cages containing 100 flies each. Within 30 minutes over 90 percent of the insects were gone. It took flypaper, fly traps, and bait cards anywhere from 15 to 86 hours to suppress the populations that much.

Moving to fleld tests, the researchers placed pairs of twoyear-old muscovies on several Ontario farms. Videotapes showed the birds snapping at houseflies and biting flies about every 30 seconds and being successful on 70 percent of their attempts. With that efficiency, they achieved 80-90 percent fly control in

enclosures such as calf rooms or piggeries. The birds were given only water and had to scavenge for all their food. Females seemed to eat about 10 percent more flies than males, and individuals of any age between eight days and two years were equally effective.

The birds fit the practical needs for farmyard fly control. They stayed close to piglets and calves, to which flies are particularly attracted. They even snatched flies off the hides of resting animals without waking them up. On one farm, the birds huddled between sleeping piglets and were accepted by the sow lying beside them. This was noteworthy because most fly-catching devices (chemical, electrical, or mechanical) must be kept far from animals.

To the Canadians, the economic advantages are clear. A 35-cow dairy needs $150-$590 worth of chemicals for controlling flies during the fly season; muscovy chicks, on the other hand, cost less than $2 each, eat for free, and can be sold for a profit of 200-400 percent.

The researchers point out that employing muscovies does not eliminate all need for insecticides, but it reduces the amounts required. And muscovies are biodegradable, will not cause a buildup of genetic resistance, and taste better than flypaper. Indeed, their meat is excellent, and the naturally mute birds seldom make any noise.

Reportedly, muscovies are kept in some houses in South America to control not only flies, but also roaches and other insects.

USES

The muscovy is generally raised only for its meat, which is of excellent quality and taste. In stews it is hard to distinguish from pork; cured and smoked it is similar to lean ham.4 The fat content is low.

Muscovy eggs are as tasty as other duck eggs, and a muscovy female can supply a large number if she is kept from sitting.

These birds are useful for clearing both terrestrial and aquatic weeds.5

Down feathers are used, like those of other ducks, in clothing and comforters.

HUSBANDRY

Muscovies may be raised like common ducks. An ideal grouping is one male to five or six females.

Except in Taiwan, France, Hungary, and a few other European countries, they exist predominantly in small flocks in farmyards and village ponds. However, they can be reared under intensive conditions in a shed or pen that is well lighted and equipped with low roosts and bedding. Under such conditions, they may be fed diets recommended for rearing common ducks or given coarse feeds, including whole grain. If chicken rations are used, fresh greens must be provided to avoid "cowboy" legs, a symptom of niacin deficiency.

Although they thrive in areas where there is abundant water, they do not require access to swimming water. They prefer to nest under cover and will use nesting boxes. A normal clutch size is 9-14 eggs; however, clutches of up to 28 can occur. There may be 4 clutches annually, and (when the hen does not have to brood the

ducklings) some muscovies have laid 100 eggs in a year.6

The egg weight, which increases with the female's age, ranges from 65 to 85 g. The eggs require 33-35 days to hatch, a week longer than the common duck's. Hatching success of 75 percent or more is common.

Compared with domestic ducks early growth is slow, which is perhaps why muscovies have not enjoyed wider industrial use. However, after the slow period they grow rapidly and, because they forage on a broader range of vegetation than common ducks, they can scavenge a large proportion of their diet at little or no cost.

When raised intensively, females average 2 kg and males 4 kg at 11-12 weeks of age. Females may reach sexual maturity by 28 weeks of age; males require a month more.

THE MULE DUCK OF TAIWAN

In parts of Europe, hybrids between muscovies and common ducks are reared for fattening. However, Taiwan has made the most outstanding use of this "mule duck." Thanks in part to this muscovy hybrid, Taiwan's duck industry has grown rapidly in the last decade. The total value of duck products now exceeds $346 million per year. Much of the boom in duck production is due to improved feeding disease control and management systems, but much is also due to the performance of the mule duck.

This hybrid is now Taiwan's major meat-duck breed, and about 30 million are consumed each year. Indeed, the duck industry has been so successful that

Taiwan is increasingly exporting frozen duck breast and drumstick meat to Japan. It now provides 24 percent of the duck meat eaten in Japan- most of it coming from mule ducks. Also, Taiwan is exporting partially incubated mule-duck eggs throughout Southeast Asia. And mule ducks supply most of the raw material for Taiwan's large feather industry.

Taiwan farmers have been producing mule ducks for 250 years, but the recent jump in production is due to the use of artificial insemination to overcome the natural reticence of the different species to mate. Fortunately, artificial insemination is well developed and is a standard part of farming practice in Taiwan.

Mule ducks are successful because they have less fat than a broiler chicken and they grow faster. Indeed, they can reach a market weight of 2.8 kg at 65 - 75 days of age, depending upon the weather, season, and management. In part, this fast growth is because they are sterile and waste no energy in preparing for a sexual existence or in laying eggs.

The usual cross employs a muscovy male and a domesticduck female. The domestic breeds most employed for muleduck production are White Kaiya (Pekin male x White Tsaiya female), Large White Kaiya (Pekin male x White Kaiya female) and colored Kaiya. Both sexes of the hybrid offspring weigh about the same.

Crosses between a muscovy hen and a domestic drake are much rarer (traditionally, this was because of the different mating behavior of the two species, but even with artificial insemination available they are not much used) and the males of these hybrids are much heavier than the females. Females of this

cross do lay eggs, but the eggs are small (about 40 g) and their embryos do not develop.

There are almost 300 duck-breeding farms in Taiwan, annually producing more than 600,000 female domestic ducks for use in producing mule ducks. Some farmers combine duck raising with fish farming. The excrete of 4,000 ducks on one hectare of pond can provide 30,000 tilapia with 20 percent of their feed. It helps the farmer get rid of waste as well as giving him fresh fish to sell.

ADVANTAGES

As noted, the muscovy is an extremely good forager and thrives under free-ranging conditions. Unlike other ducks, it grazes on grass and leaves and will maintain itself on pasture. Apparently, it can digest bran and other fibrous feeds better than common ducks can.

The males are larger than all but the largest strains of table duck. They have exceptionally broad, well-muscled breasts and provide one of the leanest meats of any waterfowl.

The muscovy is apparently more resistant to diseases that regularly decimate other poultry. This is one reason why villagers favored them: when chickens die, muscovies often survive.

The female's strong parental qualities help assure the survival of ducklings with a minimum of human intervention. Her ability to incubate and hatch most other poultry eggs is an added advantage to small farmers who have neither the capital to buy, nor the knowledge to operate, artificial incubators.

Unlike other ducks, muscovies are not easily alarmed, and fright does not affect their egg production and laying. Indeed, they are so phlegmatic that automobiles can be major causes of death.

LIMITATIONS

Because they are a tropical species, these birds are much less tolerant of cold than common ducks and require more protection from freezing weather.

The muscovy's feed conversion is not as good as the chicken's. Also, compared with some other meat-duck breeds, muscovies have a slower rate of growth and require about 4 6 weeks longer to attain maximum development of breast muscles.

Muscovies can be difficult to handle. If their legs are free, the handler may be badly lacerated by the claws.

Although adults have a fair homing ability, muscovies may wander away when local forage is sparse, and young birds may be carried long distances downstream, never to return.

Because they feed on greenery, they can devastate gardens if the plants are very young.

Muscovies can be unsuspected carriers of poultry diseases, so that healthy-looking muscovies may infect the other species.

RESEARCH AND CONSERVATION NEEDS

Poultry scientists should unite in efforts to advance technical knowledge and public appreciation of this bird. Governments and researchers should begin evaluations of local varieties and their uses and performances. The experiences of France, Italy, Eastern Europe, and Taiwan should be gathered and made available for a worldwide readership.

It is important that the many muscovy varieties within the countries of Latin America - where the bird has a centuries-long history of domestication - be maintained and studied. Many superior varieties and specimens may be awaiting discovery.7

The muscovy's nutritional requirements, range and confined systems of management, and disease vulnerability are poorly understood and need study. Especially needed are ways to increase growth rate.

10 Pigeon

FIGURE

Pigeons (Columba livia)1 are durable birds that can be raised with little effort. Able to survive in inhospitable climates, they fend for themselves - often ranging over many square kilometers to locate seeds and edible scraps. They have been raised for centuries, especially in North Africa and the Middle East. In parts of North America and Europe, they are produced as a delicacy for the gourmet market. But raising pigeons for food is not nearly as widespread as it could be; indeed, in modern times its potential has hardly been touched. Farmed pigeons are particularly promising as urban microlivestock because they require little space and thrive in cities.

Young pigeons (squab) grow at a rapid rate. Their meat is finely textured, has an attractive flavor, and is often used in place of game fowl. Tender and easily

digested, it commands premium market prices. In many areas, the continuing demand is unfilled.

Pigeons are traditionally raised in dovecotes - "houses" that protect the birds from the elements and from predators. This system allows free-ranging flight and requires almost no human intervention. Dovecotes are a good source of both squab and garden manure, and they continue to be used, especially in Egypt. On the other hand, pigeons can also be raised in confinement - usually in enclosed yards - with all their needs supplied by the farmer. There are, for example, pigeon farms in the United States with up to 35,000 pairs of breeding birds.

Pigeon production may never rise enough to compete with commercial poultry as a major source of food, but for Third World villages these birds could become a significant addition to the diet as well as a source for substantial supplemental income.

AREA OF POTENTIAL USE

Worldwide.

APPEARANCE AND SIZE

Pigeons have small heads, plump, full-breasted bodies, and soft, dense plumage. They weigh from about 0.5 to nearly I kg. A few large breeds (Runts, for instance, which commonly weigh 1.4 kg) are the size of small domestic chickens.

Many breeds have been developed for meat production. They produce squab that grow quicker and have larger breasts than unselected birds.

DISTRIBUTION

The wild ancestor of the common pigeon - domestic, wild, or feral - is thought to be the rock pigeon or rock dove of Europe and Asia. Today its domestic descendants are bred in virtually every country, and those that have gone feral (reverted to the wild) occur in most of the world's cities and towns.

STATUS

They are abundant. However, as with most other domestic species there is concern over the decline and loss of certain breeds. Societies have been organized (notably in the United Kingdom) to preserve rare types.

Natural habitat of the rock dove ancestor of the domestic pigeon

HABITAT AND ENVIRONMENT

The domestic pigeon can be raised equally well in temperate and tropical zones. Indeed, this adaptable species can be kept anywhere that wild pigeons exist,

including arid and humid regions. It should be noted, however, that cold climates do not favor squab production and hot climates promote vermin and disease.

BIOLOGY

The pigeon's natural diet consists mostly of seeds, but includes fruits, leaves, and some invertebrates. Feral pigeons consume a wide array of materials, including insects, bread, meat scraps, weed seeds, and many kinds of spilled grains at mills, wharves, railway yards, grain elevators, and farm fields.

For the first four or five days of life, the young are fed "crop milk." This substance, common to pigeons and doves,2 is composed of cells from the lining of the crop and is very high in fats and nutritional energy. The phenomenal growth rate of young squab has been attributed to crop milk and to its early replacement (within 8-10 days) with concentrated foods, regurgitated by both parents. The parents feed the squab for about four weeks before pushing it out of the nest to prepare for the next clutch.

In domestic birds, sexual maturity (as measured by age at first egg) is reached at 120-150 days. Life span can be 15 years, although growth and egg production decline rapidly after the third year.

BEHAVIOR

Wild pigeons often nest on cliff sides. Domestic pigeons prefer to nest around buildings, in nooks and shelves and under the eaves - that is, in "pigeonholes."

In domestic varieties, the pair-bond often lasts until severe illness or death.

Sometimes, however, a vigorous male will "invade" a nest and mate with the females there. Both sexes take nearly equal part in nest building, incubation, and caring for the young. Typically, there are two eggs to a clutch. Eight clutches a year is not uncommon for a breeding pair. The incubation period is 17-19 days.

Unlike most birds, pigeons drink by inserting their beaks into water and sucking up a continuous draft.

Courtship is characterized by cooing, prancing, and displays of spread, lowered tail feathers. "Bow and coo" exhibitions are unique to pigeons and doves and differ among species.

USES

Pigeons are usually raised exclusively for meat. The squab are harvested just before full feather development and before the youngster has started to fly, usually at 21-30 days of age. At this time the ratio of flesh to inedible parts is highest; once flying begins, the meat becomes tougher. Weight depends upon breed, nutrition, and other factors, but usually ranges from 340 to 680 g.

Pigeons are extensively used for scientific research, notably in physiology and psychology. They are also widely kept as pets for plumage and for racing. The pigeon's unique homing ability was recognized in Roman times, and the birds have been trained to return to the dovecote from as far away as 700 km. Even today, homing pigeons are used to carry messages, especially during war.

HUSBANDRY

Pigeons are easily trained to recognize "home." The wing feathers are clipped and the birds are fed close to the dovecote; by the time they refledge, their homing instinct has been developed. Alternatively, newly captured pigeons may be trained by confining them to the dovecote for at least one week. At first, a little grain is provided in the morning (this is to ensure the birds will return to the coop). The birds can obtain the rest themselves.

Any waterproof house that is easy to clean is suitable for keeping pigeons. Many traditional dovecotes are built of earthenware pots. In Asia and Europe, wooden pigeon towers are generally used.

Unlike chickens, pigeons do not prefer communal roosts. Instead, they prefer nesting shelves, of which there should be two for each breeding pair. The shelves are usually placed in dark corners and are fitted with low walls to keep eggs from rolling out.

Grit is important in the diet, both to provide minerals and to allow the birds to grind feed in their gizzards.

Commercial squab breeds are often kept permanently in pens, a process that requires care and experience. Growers expect an average of 12-14 squab per pair per year, although much depends on environment and management.

The birds need fresh water daily and water for bathing at least weekly. Since they feed their young by regurgitation, the adults must have a continuous supply of clean drinking water. Orphan squab can be fed egg yolk until old enough to consume adult feeds.

Like all poultry, confined pigeons must be provided enough supplemental feed to ensure a balanced diet. A mixture of whole grains can be fed for maximum production. It is important that grains be dry and free of mold (pigeons will not thrive on mash). Peas, beans, or similar pulses make good supplements.

CARRIER PIGEONS

Most people consider message-carrying pigeons to be a quaint anachronism. But in a few countries (both developed and developing) carrier pigeons are making a comeback, and in the future they may be used routinely once again.

New techniques are making this process far more practical than before. For example, in the past the pigeons would be flown in one direction only. They were transported away from home and at the appropriate time released to find their way back. That was very limiting. But it has since been found that pigeons can be trained to carry messages in two directions: flying from one point to another and then back again. They will do it twice a day, and with almost perfect reliability. The key is to place the feeding station at one end and the nest at the other. This limits the pigeon's range, but they still can handle round-trip distances up to 160 km.

With a little ingenuity, there is no need for a person to monitor the stations to receive the messages as the bird arrives. One simple technique is to arrange the station with one-way doors - one opening inwards, the other outwards. Placing a bar across the outward door means that the bird cannot get out until someone releases it. Thus the message can always be retrieved.

This system has been employed in Puerto Rico and Guatemala, but it could be used almost anywhere. In many parts of the Third World, in particular, there are remote areas with no phones and with hilly, rough terrain where delivering messages can take hours of strenuous travel. Some locations are subject to unexpected isolation by natural calamities or military or terrorist actions.

In Puerto Rico, for instance, we kept pigeons in a village 32 km from the capital. The pigeons could get downtown in 20-30 minutes. It took us 1.5-2 hours each way by road. What was easy for the birds was a major trip for us. Pigeons carried the villagers' requests for certain foods and medicines. Our contact in the city then sent up the supplies by bus. The birds never let us down.

Carrier pigeons are useful for more than just flying far and fast. They have been bred for racing and their large pectoral muscles make them excellent meat producers - much better than the common pigeons normally raised for food. A pair of carriers typically will raise 12 - 16 young each year, and those not needed for message carrying can be butchered at 28 days of age - yielding meat that is nutritious and considered a delicacy in many countries.

David Holderread

Every day on the northwest coast of France, Petit Gendamme, a black and white carrier pigeon, flies on average 23 km between hospitals on his blood delivery route. Trussed in tiny hand-sewn harnesses, he and a flock of carrier pigeons set out (except during the hunting season) with little red tubes of blood secured to their breasts.

"It's a simple, effective, and cost-saving transport system," said Yves Le Henaff, head of the Avranches Hospital laboratory, Cotentin, France, a central blood-testing center that serves a number of isolated medical centers along the coast.

The service becomes particularly valuable during the summer tourist rush, when travellers flock to the seashore to visit nearby Mont Saint Michel, crowding the small country roads and increasing the risk of traffic accidents.

The birds' average flight time between the hospitals of Avranches and Granville, for example, a distance of about 27 km, is 20 minutes, including the time for harnessing up. And with a favorable western wind their best time can reach 11 minutes.

While gasoline costs the equivalent of $0. 75 a lifer in France, hospital officials say that a few grains of corn is all it takes to run this operation. According to Le Henaff, who supervises the carrier pigeon operation, the hospital is saving up to $46 a day on gas and auto maintenance.

The 40-year-old Le Henaff got the idea five years ago from an article in a scientific journal describing a similar experiment in Britain. A year later, he and an associate called on the local seamstress to design a light harness that could hold a tube, which, when filled, weighs approximately 39 g.

The flock now consists of 40 veteran fliers and 20 carrier pigeons in training.

And what if the winged creatures stray en route? Le Henaff has devised a fall-back option: two pigeons carry two different test tubes containing the same blood sample.

The birds fly every day of the year with the exception of the three-month autumn hunting season. Since the beginning of the experiment four years ago, there have been two casualties. Le Henaff believes the birds probably met their fate in some Normand's oven.

Sometimes weather is a factor, and heavy fog can keep the delivery team grounded.

So far, the new job seems to benefit the pigeons, too. Unlike sickly city pigeons, whose average life span is about four years, well-cared-for carrier pigeons can live up to 15 years, Le Henaff said. "And how many people do you know who are willing to stay with the same outfit for that long?"
Sabine Maubouche
The Washington Post
December 2, 1986

ADVANTAGES

Under extensive conditions - where the birds are released each day to feed themselves - almost no land is needed. Under intensive conditions, where the birds spend their lives in confinement, a mere half hectare can be enough space to raise 2,000 pairs.

Free-ranging pigeons forage over a wider area than most domestic fowl because they fly out to find their feed. Nutrient requirements3 are similar to those of chickens and other fowl (making allowance for the energy needed for flying), so commercial feed and other supplements - if needed at all - are generally available.

In dovecote culture, pigeons require little or no handling. They brood the young with little intervention. Although not continuous, the production of meat from these fast-growing, rapidly reproducing birds is more sustained than with most livestock.

Almost nowhere are there taboos against consuming pigeon meat. Prices received for squab are normally high, and in most places the demand is constant. The only limitation in some areas is the absence of an effective market, which is usually easy to create.

Squab contains a larger proportion of soluble protein and a smaller proportion of connective tissue than most meats and is therefore good for invalids and people with digestive disorders.

As many hobbyists can testify, raising pigeons can be gratifying.

LIMITATIONS

Pigeons are subject to few diseases. However, worms, lice, diarrhea (coccidiosis), canker (trichomoniasis), and salmonella (paratyphoid) occur at some time in most domestic breeds. Salmonella exists in low levels in most flocks and will flare up if birds are stressed. Treatments recommended for domestic chickens are usually suitable for pigeons.

By flying over a wide area and eating grains and other foods, pigeons can cause conflicts with farmers. Indeed, in the 13th century the aristocracy's pigeons became a major grievance of the peasants who saw their seed devoured. On the other hand, "croppers" (breeds with large crops) were developed to steal grain

from the lord's fields. The pigeon returned home and his crop was emptied of the grain, which was used by the peasant to make bread.

The birds can become nuisances. They leave droppings in annoying places, some people find them too noisy, and a few people are severely allergic to "pigeon dust."

Every conceivable type of predator can be expected; therefore, precautions must be taken. The dovecote must be well protected against rats, which are the principal enemy of the eggs and the squabs.

Nesting birds need a high-protein diet to raise squab at the high rates of gain that are possible.

RESEARCH AND CONSERVATION NEEDS

Poultry researchers should study the increased role pigeons might play in Third World economic development. Nothing comparable to the sophisticated selection employed with the domestic chicken has so far been attempted. Given such attention the gains could be great.

Among pressing research needs are:

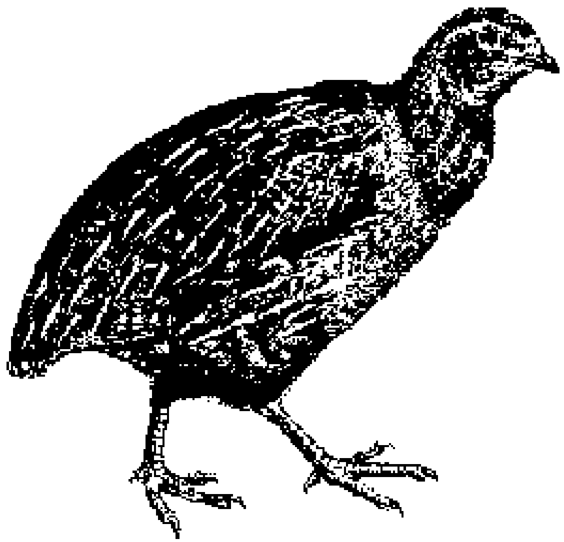
- Breeding. This needs to be better understood. For example, the effects of hybridization and inbreeding need clarification.

- Environmental limits. Little work has been done outside the temperate regions.

- Diseases. These deserve increased attention.

There is also the potential of "dovecotes" for wild pigeons. Numerous local species are well adapted to local conditions, and these deserve to be tested for "domestication."4 Many wild species quickly lose their fear of man, and in time they can even become too fat to fly. Wild pigeons are already found throughout the humid tropics and are trapped for meat and rearing in New Guinea and other places. They are already an important food source for many subsistence farmers and shifting cultivators, and with some dovecote management could provide a greater, more dependable source of food and income. The potential for domesticating local pigeon species, especially those suited to the tropics, deserves exploration.

11 Quail



FIGURE

Native to Asia and Europe, quail' (Coturnix coturnix2) have been farmed since ancient times, especially in the Far East. They reproduce rapidly and their rate of egg production is remarkable. They are also robust, disease resistant, and easy to keep, requiring only simple cages and equipment and little space. Yet they are not well known around the world and deserve wider testing.

Quail are so precocious that they can lay eggs when hardly more than 5 weeks old. It is said that about 20 of them are sufficient to keep an average family in eggs year-round. Quail eggs are very popular in Japan, where they are packed in thin plastic cases and sold fresh in many food stores. They are also boiled, shelled, and either canned or boxed like chicken eggs. Quail eggs are excellent as hors d'oeuvres and they also are used to make mayonnaise, cakes, and other prepared foods.

In France, Italy, the United States, and some countries in Latin America (Brazil and Chile, for example) as well as throughout Asia, it is the meat that is consumed. It is particularly delicious when charcoal broiled. One company in Spain annually processes 20 million quail for meat.

Many of the domesticated strains seem to have originated in China, and migrating Chinese carried them throughout Asia. Today, millions of domestic quail are reared in Japan, Indonesia, Thailand, Taiwan, Hong Kong, Indochina, Philippines, and Malaysia, as well as in Brazil and Chile.

Commercial production is carried out, as in the chicken industry, in specialized units involving hatcheries, farms, and factories that process eggs and meat. However, quail have outstanding potential for village and "backyard" production

as well. It is this aspect that deserves greater attention.

AREA OF POTENTIAL USE

Worldwide.

APPEARANCE AND SIZE

Quail come in various sizes. The smaller types are used for egg production, whereas the larger ones are better for meat. Adult females of improved meat strains may weigh up to 500 g.

There are several color varieties. However, mature females are characterized by a tan-colored throat and breast, with black spots on the breast. Mature males, which are slightly smaller than females, have rusty-brown throats and breasts. All mature males have a bulbous structure, known as the foam gland, located at the upper edge of the vent.

In the United States, the Pharaoh strain is the bird of choice for commercial production. Other available strains tend to be bred more for fancy than for food.

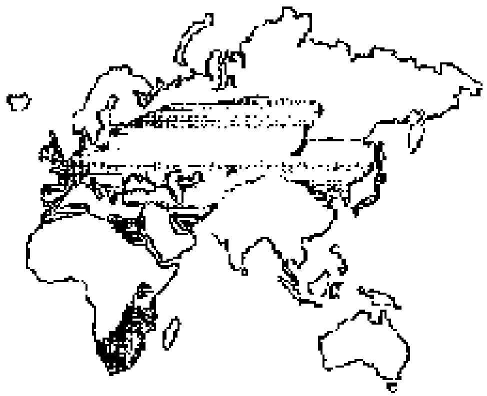
Quail eggs are mottled brown, but some strains have been selected for white shells. These eggs are often preferred by consumers and are easier to candle (the process of holding eggs up to a light to check for interior quality and stage of incubation). An average egg weighs 10 g - about 8 percent of the female's body weight. (By comparison, a chicken egg weighs about 3 percent of the hen's body weight.) Quail chicks weigh merely 5-6 g when hatched and are normally covered in yellowish down with brown stripes.

DISTRIBUTION

The ancestral wild species is widely distributed over much of Europe and Asia as well as parts of North Africa. Although domestic quail are now available almost everywhere, Japan is probably the world leader in commercial production; quail farms are common throughout its central and southern regions.

STATUS

Not endangered.



The natural distribution of the quail (*Coturnix coturnix*). The subspecies identified are: (1) European quail (*C. c. coturnix*); (2) Ussuri quail (*C. c. ussuriensis*); (3) Japanese quail (*C. c. japonica*); (4) African quail (*C. c. africana*). Only the Japanese quail is now widely used in domesticated form.

figure

HABITAT AND ENVIRONMENT

Quail are hardy birds that, within reasonable limits, can adapt to many different environments. However, they prefer temperate climates; the northern limit of their winter habitat is around 38°N.

BIOLOGY

A quail's diet in the wild consists of insects, grain, and various other seeds. To thrive and reproduce efficiently in captivity, it needs feeds that are relatively high in protein.

The females mature at about 5-6 weeks of age and usually come into full egg production by the age of 50 days. With proper care, they will lay 200-300 eggs per year, but at that rate they age quickly. The life span under domestic conditions can be up to 5 years. However, second-year egg production is normally less than half the first year's, and fertility and hatchability fall sharply after birds reach 6 months of age, even though egg and sperm production continue. Thus, the commercial life is only about a year.

Crosses between the wild and domestic stocks produce fertile hybrids. Repeated backcrossing to either wild quail or domestic quail is successful.

BEHAVIOR

Only females hatch the eggs and raise the chicks. Males go off and court other females when their partners begin the nesting process.

USES

Quail eggs taste like chicken eggs. They are often served hard boiled, pickled, fried, or scrambled. Because of their size they make attractive snacks or salad ingredients. They provide an alternative for some people who are allergic to chicken eggs. On frying, the yolk hardens before the albumen.

Quail meat is dark and can be prepared in all of the many ways used for chicken. The two meats are similar in taste, although quail is slightly gamier.

Because of its hardiness, small size, and short life cycle, quail are now commonly used as an experimental animal for biological research and for producing vaccines - especially the vaccine for Newcastle disease, to which quail are resistant.

Many fanciers and hobbyists have also become interested in raising this adaptable species as a pet. Science teachers find it an excellent subject for classroom projects.

QUAIL IN JAPAN

In some areas of Japan, quail are widely raised for their eggs and meat. However, Japanese originally valued the quail as a songbird. Tradition has it that about 600 years ago people began to enjoy its rhythmic call. In the feudal age, raising song quail became particularly popular among Samurai warriors. Contests were held to identify the most beautiful quail song and birds with the best voices were interbred in closed colonies. Even photostimulation was practiced to induce singing in winter.

Around 1910, enthusiastic breeders produced the present domestic Japanese quail from the song quail. It was created as a food source and became a part of Japanese cuisine. During World War II it was almost exterminated, but Japanese quail breeders restored it from the few survivors and from birds imported from China. The original song quail, however, were lost. In the 1960s, commercial quail flocks rapidly recovered and Japan's quail population again reached its prewar

level of about 2 million birds.

A QUAIL IN EVERY POT: AN OLD DELICACY FINDS A NEW PUBLIC

For centuries, quail were considered a great delicacy: a dish that only eminent chefs would cook and diners with an appreciative palate could enjoy. These small migratory birds, which are found in one variety or another throughout the world, were available until recently almost exclusively to hunters in the wild.

But now quail are in danger: in danger of becoming commonplace.

In the last few years, quail have gone from being rarefied to a supermarket specialty item. They are on menus in the most elegant restaurants and the most casual cafes and bistros.

Why so much interest?

Quail are now available semi-boneless, which makes them faster and easier to cook, and easier to eat as well. The breastbones are removed by hand before the birds are packaged and shipped to stores. The bones in the wings and legs remain.

A stainless-steel V-shaped pin - invented and patented by a restaurant chef who wanted a way to keep quail flat for grilling- is inserted into the breast. The pin can be left there throughout cooking and removed just before serving.

While whole quail might require 45 minutes to cook, the semi-boneless variety can be grilled in less than 10 minutes, or pan-roasted, braised or sauteed in less than 20 minutes.

The flavor of farm-raised quail has also helped bring them into the mainstream. Most farm-raised quail have tender meat like the dark meat of chicken, whose flavor is enjoyed by many people.

And at a time when people are searching for foods, specifically animal protein, with low fat and cholesterol, quail fills the bill. The Agriculture Department says that quail skin has about 7 percent fat, about the same as dark meat of roasted chicken without the skin.
Judith Banrett Adapted from The New York Times
June 21, 1989

HUSBANDRY

It is necessary to keep quail in battery cages on wire floors because males secrete a sticky foam (from the foam gland) with their feces; on a solid floor, this adheres to the feet and collects dung, leading to crippling and breakage of eggs.

Adult quail can live and produce successfully if they are allowed 80 cm2 of floor space per bird. However, for reproduction about twice that is needed to allow for mating rituals.3 If properly mated, high fertility rates and good egg hatchability can be expected. To obtain fertile eggs, one male is needed for roughly six females.

Eggs hatch in about 17 days. Chicks require careful attention. Brooding temperatures of between 31 C and 35 C are needed for the first week and above 21 C for the second week. From the second week on, chicks can survive at room temperature. (These temperatures are similar to those required for common

chickens.) In cold climates, supplemental heat may be needed as well as protection from cool drafts.

Clean water must be provided at all times, with care taken to prevent the chicks from drowning in their water troughs. Shallow trays, jar lids, or pans filled with marbles or stones may be used.

ADVANTAGES

Quail production can be started with little money. These easy-care birds can be housed in small, simple, inexpensive cages.

As noted, they are resistant to Newcastle disease.

SIX OF ONE, HALF A DOZEN OF THE OTHER

The fact that chickens can be crossed with quail has been known for some time, but there has been little attempt to develop the fertile hybrids. Now Malaysia has begun a project aimed at producing a new poultry bird - a cross between a cockerel and a hen quail. Zainal Abidin bin Mohd Noor, of the Department of Veterinary Services in Kuala Lumpur, is creating a strain that produces eggs of good quality and meat with the flavor of both parents. The new bird is intermediate in size between chicken and quail which is convenient because it is about right for an individual helping.

The crossbreeding is done through artificial insemination. The progeny exhibit a range of appearances, sizes, and plumage colors, depending on the strains of cockerel and quail hens used. In the Malaysian research, cockerels have been local

Ayam Kampung Bantam, Hybro, and Golden Comet hybrids. The quails have been local inbred Japanese quail (IJQ) and imported meat strain quail (IMSQ).

The trials show that the hybrids derived from the IMSQ flocks grew faster and bigger than those from the IJQ cross. The best have been the Hybro x IMSQ crosses, which weigh 475 g at 10 weeks of age. The best of the IJQ group weighed 290 g during the same period.

This type of "tropical game hen" might be a way to introduce hybrid vigor into poultry production.

The researchers who developed the hybrid have named it the "yamyuh."

LIMITATIONS

Although generally disease resistant, quail are affected by several common poultry diseases, including salmonella, cholera, blackhead, and lice. They also suffer epidemic mortality from "quail disease" (ulcerative enteritis), which can, however, be controlled with antibiotics.

Quail seem to require more protein than chickens, and produce best when given feed that is fairly high in protein.4 However, they also perform satisfactorily when fed rations designed for turkeys. They have high requirements for vitamin A, which they do not store.

Quail are not suitable as free-ranging "scavengers." They must be kept confined, which is a major constraint. Unlike chickens or pigeons, they have no homing instinct and will not remain on a given site; if released, they will be lost. In

addition, since they nest on the ground, they are highly susceptible to predation; they must be protected, especially where certain animals, the mongoose for example, are common.

Artificial incubation is essential. Natural incubation using the female is futile; the females do not go broody and rarely incubate their eggs. The shells are extremely thin, but the eggs can be incubated under a small chicken hen, such as a bantam.5 The eggs are also subject to minute fractures. However, the shell membrane is extremely tough and unfertilized eggs are generally unaffected, but the cracks cause fertilized embryos to dehydrate and die. This is a serious limitation. Whenever quail husbandry is introduced, artificial incubation should be included.

RESEARCH AND CONSERVATION NEEDS

Quail deserve to be included in all poultry research aimed at helping the Third World. Through its international scientific program, Japan, in particular, could apply to developing nations its vast experience with quail farming.

Experiences with quail in the tropics (for example, Japanese farmers in the Amazon Basin) and in tropical highlands (for instance, in India, Nepal, or Central Africa) should be collected and assessed to improve understanding of the environmental limits to Third World quail farming.

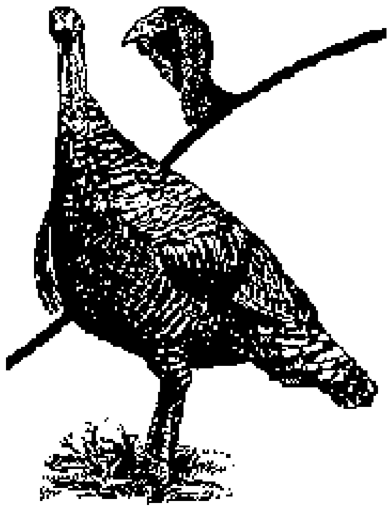
Cooperation between commercial and laboratory quail breeders should be encouraged. Mutants found at the commercial level would be useful for laboratory work. Conversely, introducing new stocks could help the farmer. In both cases, more genetic diversity might also lead to the production of hybrid vigor, and

genetic variability would be conserved.

Sex-linked genes, if they can be found, would be useful to the commercial quail breeder for the rapid sexing of newly hatched chicks. This could lead to more efficient production techniques, like those in the chicken industry.

Although virtually all work to date has been on the Japanese quail, other species and subspecies warrant research and testing.

12 Turkey



FIGURE

The turkey (Meleagris gallopavo) is well-known in North America and Europe, but in the rest of the world, especially in developing countries, its potential has been largely overlooked. Partly, this is because chickens are so familiar and grow so well that there seems no reason to consider any other poultry. Partly, it is because

modern turkeys have been so highly bred for intensive production that the resulting birds are inappropriate for home production.

Nevertheless, there is a much wider potential role for turkeys in the future. There are types that thrive as village birds or as scavengers, but these are little known even to turkey specialists. These primitive types are probably the least studied of all domestic fowl; little effort has been directed at increasing their productivity under free-ranging conditions. However, they retain their ancestral self-reliance and are widely used by farmers in Mexico. That they are unrecognized elsewhere is a serious oversight.

Native to North America, the turkey was domesticated by Indians about 400 BC, and today's Mexican birds seem to be direct descendants.' Unlike the large-breasted, modern commercial varieties, they mate naturally and they retain colored feathers and a narrow breast configuration. Their persistence in Mexico after 500 years of competition with other poultry highlights their adaptability, ruggedness, and usefulness to people.

These birds complement chicken production. They are able to thrive under more arid conditions, they tolerate heat better, they range farther, and they have higher quality meat. Also, the percentage of edible meat is much greater than that from a chicken. Turkey meat is so low in fat that in the United States, at least, it is making strong inroads into markets that previously used chicken exclusively.

Turkeys are natural foragers and can be kept as scavengers. Indeed, they thrive best where they can rove about, feeding on seeds, fresh grass, other herbage, and insects. As long as drinking water is available, they will return to their roost in the

evening.

Appreciation for the turkey could rise rapidly. Interest already has been shown by several African nations. A French company has created a strain of self-reliant farm turkeys and is exporting them to developing countries.2 Researchers in Mexico are displaying increased interest in their national resource. And as knowledge and breeding stock continue to be developed, it is likely that village turkeys will become increasingly popular around the world.

AREA OF POTENTIAL USE

Worldwide.

APPEARANCE AND SIZE

Modern turkey breeding has been so dominated by selection for increased size and muscling that commercial turkeys have leg problems and cannot mate naturally (they are inseminated artificially). These highly bred birds are adapted for large-volume intensive production, and must be raised with care. As noted, this chapter emphasizes the more self-reliant, less highly selected turkeys found in Mexico and a few other Latin American countries. They do not require artificial insemination, and with little attention can care for themselves and their young.

Fully grown "criollo" turkeys of Mexico are less than half the size of some improved strains. Males weigh between 5 and 8 kg; females, between 3 and 4 kg.3 They vary in color from white, through splashed or mottled, to black. The skin of the neck and head is bare, rough, warty, and blue and red in color. A soft fleshy protuberance at the forehead (the snood) resembles a finger. In males it swells

during courtship. The front of the neck is a pendant wattle. A bundle of long, coarse bristles (the beard) stands out prominently from the center of the breast.

DISTRIBUTION

The unimproved domestic turkey is essentially limited to central Mexico and scattered locations throughout nearby Latin American countries. Some village birds are also kept in India, Egypt, and other areas, but these are descended from semi-improved strains exported from North America and Europe in earlier times. Generally speaking, few turkeys are found in tropical countries outside Latin America.

STATUS

Domesticated turkeys are not endangered; there are estimated to be about 124 million in the world. However, the wild Mexican varieties, ancestors to the first domesticated turkeys sent to Europe, may now be endangered since their distribution in southwestern Mexico has been greatly reduced. Certainly, some primitive domestic strains in the uplands of central Mexico are also being depleted. A separate type, independently domesticated by the Pueblo Indians of the southwestern United States, seems to have disappeared entirely.

HABITAT AND ENVIRONMENT

Turkeys can be reared virtually anywhere. Their natural habitat is open forest and wooded areas of the North American continent, but in Mexico they are raised from sea level to over 2,000 m altitude, from rainforest to desert, and from near-temperate climates to the tropics.

'he original distribution of the turkey and the occellated turkey.

The original distribution of the turkey and the occellated

BIOLOGY

The range of diet is broad. Turkeys eat greens, fruits, seeds, nuts, grasses, berries, roots, insects (locusts, cicadas, crickets, and grasshoppers, for example), worms, slugs, and snails.

Reproduction is generally seasonal and is stimulated by increasing daylength. (A minimum daylength of 12 hours is required.) The birds can reach sexual maturity at six months of age and may start breeding at this time. Ten days after first mating, the hen searches out a nest and commences laying. Industrial birds in temperate climates lay, on average, 90 eggs a year. The nondescript type of turkey

in the tropics seldom lays more than 20 small eggs (weighing about 60 am) before going broody.

BEHAVIOR

Domestic turkeys walk rather than fly, and find almost all their food on the ground. They can, however, fly short distances to avoid predators.

The commercial birds have lost many abilities for survival in the wild; they can no longer exist without human care. However, village types can do well with little management.

Turkeys prefer to make their own nests but can be induced to lay in a convenient spot if provided with nest boxes.

USES

These birds are raised almost exclusively for meat. In many countries, they are a treat for holidays, birthdays, and weddings. In their native range of Mexico and Central America, the "unimproved" birds are usually produced as a cash crop for market. They receive little care or feed, and thus they are almost all profit - providing a significant income supplement to many rural homes.

HUSBANDRY

The principles of turkey management (nutrition, housing, rearing' and prevention of disease, for example) are basically the same as those for other poultry.

In Mexico, turkeys are usually kept under free-ranging conditions around houses and villages. Some shelter and kitchen scraps are occasionally provided. A number of them, however, are confined in backyards as protection from marauders and for shelter against rain and wind.

One male can service up to 12 females. Roomy nests are needed. (As a rule, turkeys require three times the space occupied by chickens.) Most range turkeys are corralled when they begin to lay, so as to protect them from predators. Eggs may be gathered to prevent broodiness and thereby increase production. The eggs may be kept for several days (cool, but not refrigerated) if turned daily, and then may be placed under a chicken hen. (A setting chicken can be used this way to hatch up to nine eggs at a time.) Hatching takes 28 days.

As in other birds, newly hatched turkeys (poults) must be kept warm during the first weeks of life. Until they begin foraging and have full access to pasture they are usually fed broken grain or fine mash, as well as finely chopped, tender green feed.

Although free-ranging turkeys are simple to raise, confined turkeys require more complex management. The birds need uncrowded, well ventilated conditions and should be on a wire or slatted floor to reduce parasitic infections. Any feeds recommended for chicks are suitable, but the protein content should be somewhat higher; that is, about 27 percent. They can be fed mixed grains, corn, and chopped legume hay. It may be necessary to provide vitamin supplements and antibiotics and take steps to prevent coccidiosis.

"AN INCOMPARABLY FINER BIRD"

The turkey was domesticated in Mexico some time before the Conquest. It is the one and only important domestic animal of North American origin. When the Spanish arrived, they found barnyard turkeys in the possession of Indians in all parts of Mexico and even in Central America. However, the Aztecs and the Tarascans, originating in west-central Mexico, seemed to have achieved the highest development of turkey culture, and it is probable that turkeys were domesticated in the western highlands, perhaps in Michoacan. Wild turkeys of that region are morphologically very similar to the primitive domestic bronze type. Both the Aztecs and Tarascans kept great numbers of the birds, including even white ones. They paid royal tribute to their respective kings in turkeys, according to the Relacion de Michoacan. The Tarascan king fed turkeys to the hawks and eagles in his zoo. The economy of some highland tribes was based on the cultivation of corn and the raising of turkeys.
A. Starker Leopold

THE INDUSTRIAL TURKEY

The modern domesticated turkey is thought to be descended from two differing wild subspecies, one found in Mexico and Central America and the other in the United States. The southern type is small, whereas the U.S. native is larger and has a characteristic bronze plumage.

Mexican turkeys were exported to Europe soon after the Conquest, and spread rapidly. In the 17th century, some were returned to North America, where they interbred with the eastern subspecies of wild turkey, producing a heavier bird, which was then re-exported to Europe.

These types underwent little change until this century, when the Englishman Jesse Throssel bred them for meat quality. In the 1920s, he brought his improved birds to Canada, where their large size and broad breasts quickly made them foundation breeding stock. Crossed with the narrow-breasted North American types, these heavily muscled meat birds quickly supplanted other varieties.

About the same time, the U.S. Department of Agriculture began the scientific development of a smaller meat turkey derived from a more diverse genetic base. By the 1950s, the Beltsville Small Whites predominated in the home consumption market in the United States.

ADVANTAGES

The birds are efficient and generally take care of themselves. They tolerate dry, hot, or cold climates and forage farther than chickens. They are large, fast growing, highly marketable, low in fat, and tasty.

THE TURKEY'S TROPICAL COUSIN

The ocellated turkey (Agriocharis ocellata) occurs in Yucatan, Guatemala, and Belize. It is much like the common turkey in size, form, and behavior: however, unlike the common turkey, which in Mexico lives in the high mountain pine and oak forests, the ocellated turkey inhabits bushy, semiforested lowlands. This splendid bird lacks the kind of beard sported by the common turkey gobbler, is generally more metallic in appearance, and has brighter coppery colors. The chief character is a neck and head that are bare, blue, and profusely covered with coral-colored pimples. It also has a yellow-tipped protuberance growing on the crown

between the eyes.

This species is worthy of investigation by poultry researchers because it might prove to be domesticable. It was possibly domesticated by the Mayas, whose ruins often include appropriately sized stone enclosures whose soil has elevated levels of phosphorus and potassium. Even today, in the rural Peten area of Guatemala, ocellated turkeys are sometimes kept around houses as scavengers.

LIMITATIONS

Young birds are readily affected by temperature changes and must be protected from the sun as well as from sudden chills, such as may occur at night. They are particularly susceptible to dampness, especially if associated with cold. One peculiarity is the turkey's aversion to any change in feeding routine or the nature of the food.

Young turkeys are susceptible to parasitic infestation as well as to the same type of bacterial and virus diseases as chickens (for example, fowlpox and coccidiosis). Blackhead, a devastating disease of young turkeys, is carried by a common parasitic nematode, and can be contracted from chickens. Medicines are available to prevent or treat most disease and pest problems.

RESEARCH AND CONSERVATION NEEDS

Turkey development is almost nonexistent in the Third World (and much of the rest of the world, too). Although commercial turkeys are highly developed in some countries, little or no research has been conducted on the criollo turkey. Research on physiology, disease, and husbandry of the criollo turkey should be given high

priority.

The need for conservation of genetic variability is perhaps more critical in this species than in almost any other domesticated animal. The unimproved types in Mexico should be collected and assessed, and a program to conserve the stocks should be initiated. An analysis should also be made of the traditional management and performance of these birds. In addition, the four or five recognized turkey subspecies should be evaluated for their potential as seed stock for Third World countries.

13 Potential New Poultry

FIGURE

Several preceding chapters have discussed the possibilities of domesticating certain wild birds.l Here, briefly, are highlighted other wild species with qualities that might make them suitable for sustained production. It should be understood that their practical use in the long run is pure speculation; they are included here

merely to guide those interested in exploring the farthest frontiers of livestock science.

Collectively, poultry have become the most useful of all livestock- and the most widespread. Yet only a handful of species are employed. Of the 9,000 bird species, only a few (for instance, chickens, ducks, geese, muscovies, pigeons, and turkeys) have been domesticated for farm use. Strictly speaking, all birds are edible - at least none have poisonous flesh - so it seems illogical to conclude that these are the only likely candidates. Perhaps they are not even the best.

At first sight there may seem to be little need for new species, but poultry meat is in ever increasing demand and there are many niches where the main species are stricken by disease, or are afflicted by heat, humidity, altitude problems, or other hazards. For these areas, a new species might become a vital future resource. Perhaps some could even become globally important. The modern guinea fowl, for example, is a relative newcomer as a worldwide resource (see page 120).

The birds now used as poultry were domesticated centuries ago by people unaware of behavior modification, nutrition, genetics, microbiology, disease control, and the other basics of domestication. Today we can tame species that they couldn't. In particular, the new understanding of "imprinting" may make the domestication of birds easier today than ever before.

In this highly speculative concept, the birds described on the following pages are worth considering. They all eat vegetation and tend to live in flocks, which makes them likely to be easy to feed and to keep in crowded conditions. Most are sedentary, nonmigratory, and poor fliers. All but three (tinamous, sand grouse,

and trumpeters) are gallinaceous.

Gallinaceous birds are already the most important to people. The best known are chickens, turkeys, quail, and guinea fowl. But there are about 240 other species. Most are chickenlike: heavy bodied with short, rounded wings, and adapted for life on the ground. Although some are solitary, many are sociable. Basically vegetarian, they also eat insects, worms, and other invertebrates. The young birds are extremely precocious, walking and feeding within hours of hatching. All of these are advantageous traits for domestication.

Game birds are also emphasized here. Many today are considered gourmet delights, and this should give them a head start in the marketplace. Indeed, some are already being raised in a small way on game farms and are at least partly on the way to domestication.

CHACHALACAS

These brownish birds (Ortalis vetula and nine other species) are found throughout Central and South America, and, given research, could possibly be raised on a large scale. A sort of "tropical chicken," they tame easily, live together in dense populations, and protect their chicks extremely well. They commonly scavenge around houses and people often put out scraps to feed them.2 The chicks are easily hatched, grow fast, and can be fed standard chicken rations.3

There is already considerable demand for these birds. Everywhere they are found, they are prized as food. In some areas they constitute the single most important game species, and are heavily hunted to supply local communities. Although they

have less meat than a chicken, it is tastier and darker.

Chachalacas are very adaptable. They occur mainly around forest edges and thrive in the thickets that appear after tropical forests have been felled. They do well close to humans, and their populations are not threatened, despite much hunting. Indeed, they seem well adapted to existence around villages and towns. Although not strong fliers, they are one of the few tree-roosting gallinaceous species. Primarily fruit eaters, they also consume tender leaves, twigs, and buds, and they scratch up the ground, presumably for insects.

Although excitable and noisy, chachalacas become remarkably tame when fed by people. In a few cases, full domestication has almost been reached. Farmers like to have chachalacas around and have even used them to guard domestic chickens. These very raucous and fearless birds will take on all potential threats, even weasels.4

GUANS

Close relatives of the chachalacas, guans5 are glossy black birds about the size of small geese. They are highly gregarious and perhaps could be raised in larger numbers. They commonly live around houses, farms, and settlements in their native region of tropical America.

Unlike most game birds, guans are chiefly tree dwellers, but they also feed on the ground. Some 12 species are known. All are relentlessly hunted for food and sport - their tameness and inability to fly far or fast making them easy targets. The rapid destruction of tropical forests threatens their populations in some parts of their

range. Conservation projects and specific plans of action are being proposed for the most threatened species. Perhaps for the other species, game-ranching projects or even outright domestication might provide just the right incentive for their protection and multiplication.

CURASSOWS

Curassows are also relatives of guans and chachalacas, but they are even larger - up to 1 m tall and 5 kg in weight. At least seven species are found over the vast area from northern Mexico to southern South America.6 Among them are Latin America's finest game birds.

It might be possible to produce curassows in organized farming or ranching. They are commonly called "tropical turkeys" because they look like and run like turkeys. Indeed, Latin Americans normally refer to them as "pavos" or "pavones," as if they were the real thing. Their plumage ranges from deep blue to black, invariably with a purple gloss, and all have rather curly crests on their heads. They are not good fliers and spend most of their time on the ground.

Curassows are increasingly hunted; their tropical forest habitat is shrinking, and the subsequent loss of populations is a calamity. They are special targets, not only because they are large but also because their light-colored flesh makes exceptional eating.

There is hope that these large wild fowls can be raised and managed in organized programs. Even now, people commonly keep them around their farms and villages. For example, on a number of Venezuelan ranches, yellow-raped curassows can be seen wandering around the cattle yards as if they were chickens.7

FOREST BIRD RANCHING

This report has intentionally focused on intensive farming - the type where people bring feed to animals in captivity. However, where this normal type of farming is of marginal value, ´'ranching'' free-ranging birds may often be a more effective option. In this, the farmer simply monitors and improves the condition of the range and devises methods to harvest the birds on a sustainable basis.

"Bird ranching" may today have outstanding merit, particularly in tropical rainforests. Hence, in this chapter we emphasize birds of the jungle. These might help make standing rainforests profitable producers of income, and thereby provide economic incentives to stop felling trees for cow pastures. Indeed, forest birds might become part of a whole new "salvation farming'' that makes forests more valuable than fields. It is a technique that may contribute to preserving both bird life and its vitally valuable habitat.

MEGAPODES

Megapodes (family Megapodiidae) include some of the world's most interesting birds. They have temperature-sensitive beaks and employ nature's own heat sources as incubators. The best-known species build piles of leaves and use the heat of decomposition to incubate their eggs. The species of Papua New Guinea and Indonesia, however, take advantage of sun-warmed sand or even geothermal activity.

People have long revered these birds. Aborigines in Australia, Melanesians in New

Guinea, and many Micronesians all protect the bizarre nesting sites, and "farm" them for eggs. Local people consider the large eggs special delicacies, and sometimes the egg-laying sites are owned and exploited for generations without a single bird being killed for food.8

Programs that provide sustainable supplies of eggs have been established in Papua New Guinea. One is near Mt. Tovarvar, a simmering volcano on the island of New Britain. Here, megapodes gather in large numbers to lay eggs in the hot sands. They dig until they locate sand that is exactly 32.7°C, before laying their huge (more than 10 cm long and 6 cm wide) pink eggs. Each year the villagers dig up some 2O,OOO eggs, which are an important source of protein and cash income. The government now regulates the harvest in a way that protects the bird population while supplying a nourishing food.

Megapodes are found in only a few parts of the world, but projects such as those in Papua New Guinea provide hope and guidance not only for the sustainable "ranching" of megapodes, but also for other species elsewhere. Many wild birds yield locally important products- down, colored feathers, eggs, meat, and skins, and they make excellent songbirds and pets, for example. Their management on a sustainable basis may in certain cases be the key to turning local people into the most dedicated conservationists of all.

PARTRIDGES AND FRANCOLINS

Partridges include many small game birds native to the Old World. They are robust, precocious, and larger than quails. Some lay many eggs - the European partridge, for example, lays up to 26 in a clutch. Newly hatched chicks are soon

able to feed themselves and can fly within a few weeks, sometimes even within the first few days.

Species that may make useful poultry include:

- The European (or gray) partridge (Perdix perdix);

- The rock partridge (Alectoris), bantamlike birds of Africa; and

- The chukar (A. graeca).

A native of the vast area from southeastern Europe to India and Manchuria, the chukar is stocked as a game bird in many countries. It is now produced routinely under poultrylike husbandry in many parts of the United States, not only for hunting clubs, but also for expensive food markets. The birds are generally raised on turkey rations and dress out at about 500 g after 18 weeks. They sell for more than broiler chickens and are a profitable sideline for increasing numbers of poultry farmers.9

A group of closely related birds are the francolins (genus Francolinus), of which there are 34 species in Africa and 5 in West and South Asia. These adaptable birds are sturdy, live in a variety of habitats, and tend to be rather noisy. Basically, they are partridges with leg spurs. They are highly regarded as a food source and are hunted and trapped wherever they are found.

Francolins are much like quail, but are several times larger. Arabs introduced one of the most beautiful species (Francolinus francolinus) into southern Spain, Sicily, and Greece during the Middle Ages. However, it was hunted so heavily that it soon

became extinct in Europe. More recently, francolins have been introduced to the Soviet Union.'°

Francolins inhabit steppes, savannas, primeval forests, and mountains. They thrive in cultivated land with much cover. The clutch consists of 6-8 hard, thick-shelled eggs. In recent times at least one program to domesticate them for food has been started in Africa.11

MALAYSIA'S MOBILE MOUSETRAP

Although the report emphasizes microlivestock as food suppliers, it should be realized that small animals - even wild ones - can have other important uses as welt The following interesting example, with possible worldwide implications, comes from recent experiences in Malaysia. *

Certain rodents are major pests on farms and plantations. Now, however, Malaysian zoologists are finding that owls, particularly barn owls (Tyto alba), can help control them. An owl pair and its chicks annually consume 1,500 or more rodents. This is not new knowledge; indeed, on farms throughout the world the barn owl has always been a welcome guest. What is new is that Malaysians are showing how outstandingly effective this process is, and they have initiated major projects to attract and maintain these feathered friends.

Barn owls are found in many parts of the world, but were formerly almost unknown in Peninsular Malaysia. In 1969, however, a pair began nesting in an oil-palm plantation in Johore State. Since then, these birds have steadily increased in numbers and have spread throughout most of the peninsula. Today, the population

is increasing remarkably quickly as more and more managers erect nest boxes for the owls to live in.

The owls are proving to be a good way to remove rats and are notably effective in plantations of oil palm. They perch on fronds and fly under and between the rows of trees. A cost of $1 - $2 per hectare per year is all that is required to install nest boxes, a negligible outlay for the control of such a serious and expensive problem.

It is believed that the barn owls hunt mainly in plantations and other agricultural areas and not in the rainforest. Barn owls are, after all primarily adapted to open spaces and not dense forest.

Perhaps this experience can be replicated and adopted in other locations and with other crops. Grain crops - notably rice - are particularly prone to the ravages of rodents, and one trial has commenced in Selangor State in a rice area. The concept of using owls for rodent control is also catching on in the United States. Indeed owl nest boxes are being erected in Central Park in the heart of New York City.

PHEASANTS

One pheasant, the red junglefowl, gave the world the chicken (see page 86). The other 48 species may have some potential, too. These are rarely seen forest birds; all but one are confined to Asia.13 Because they are prolific they can sustain heavy predation, and many species, notably the ring-necked pheasant (Phasianus colchicus), are constantly hunted.

People in several countries have learned to exploit pheasants on farms and estates. As a result, there is a vast amount of information on how to rear and

manage these birds. So far, however, it has been applied only to sport hunting in wealthy societies; the potential of raising pheasants for the mass market should now be seriously addressed.

The most dramatic-looking pheasant, the peacock (Pavo cristatus), is raised as a poultry species in Vietnam. The meat of the young birds is considered outstanding. In fine restaurants in New York, a peacock dinner is reputed to cost $150. Common peafowls are considered sacred in many parts of India, where they have become so tame that they are essentially domesticated. They also control snakes.

QUAIL

Domestic quail have been previously described (page 146)J but dozens of wild quail species and subspecies occupy many different habitats and ecological niches in almost all parts of the world. Out of all this genetic wealth only one species - the Japanese quail - is widely used. Yet many other species seem easy to raise, becoming exceedingly tame after about the sixth generation.

The management and even perhaps intensive production of these various local quails might provide long-term benefits for many developing nations. Quail meat ranks among the finest.14 Some of these lesser-studied birds are more meaty than the Japanese quail or have other possibly useful traits. Much is known about rearing a few of them because they are used in sport hunting or laboratory research. The possibility of domestication, therefore, is not farfetched.

Particular quail that might be considered for domestication are the lesser-known subspecies of Coturnix coturnix. These subspecies are found in various places,

including the following:

- Europe (C. c. coturnix breeds in the area ranging from northern Russia to North Africa and from the British Isles to Siberia. In winter it migrates to tropical Africa, Asia, and southern India.)

- The Azores (C. c. conturbans)

- The Azores, Madeira, and the Canary Islands (C. c. confisa)

- Cape Verde Islands (C. c. inopinata)

- East Africa (C. c. erlangeri)

- Tropical Africa, southern Africa, Madagascar, and Mauritius (C. c. africana)

- Japan (C. c. japonica, the most probable ancestor of the domesticated quail)

- China (C. c. ussuriensis, a possible ancestor of the domesticated Japanese quail)

TINAMOUS

Tinamous are quail-like birds of Central and South America's forests and grasslands. They are, however, much larger than quail and resemble small chickens, with plump bodies and no visible tail. There are more than 40 species, and all are much sought for food because their meat is tender and flavorful. The breast is surprisingly large, and its flesh is pale and translucent. One species, the great tinamou (Tinamus major), has been called "the most perfect of birds for

culinary purposes." Frozen tinamous from Argentina were formerly sold in the United States under the name "South American quail."

Tinamous are found mainly in tropical areas, but are also widely distributed in Argentina and Chile. They dwell in varied habitats: rainforests, thickets, bushlands, savannas, and grasslands up to 5,000 m altitude in the Andes. Some species sleep in trees, others on the ground. They spend their days creeping about in heavy cover, flying only when forced.

At least some species tame readily. Indeed, during the nesting period males become so tractable that they can be picked up off the nest. At the turn of the century, many tinamous were raised as game birds in France, England, Germany, and Hungary. However, for reasons unknown, subsequent attempts to settle them in Europe have failed. Tinamous have been raised in Canada without undue difficulty; they showed little or no stress under captivity and there were few losses.15

Tinamous may also prove suitable for egg production. They lay clutches of 16-20 spectacular-looking shiny eggs that seem to be made of sky-blue and bright-green ceramic.

SAND GROUSE

Sand grouse (mainly Pterocles species) are highly adapted to life in arid regions - desert, dry grasslands, arid savanna, and bushveld. Their entire body (including most of the bill and feet) is covered with dense down, which in the desert insulates them from the burning heat of midday and the freezing cold of night. It

also protects the nostrils against blowing sand and dust.

These pigeonlike birds are found throughout the drier regions of Africa and Asia - for instance, the Sahara, Kalahari, Namib, Arabian, and Thar deserts. They live mainly on small seeds, and sometimes flocks of thousands may be seen at waterholes, flying in for a drink from up to 80 km away. For peoples of the driest spots on earth, these birds may make a useful food species: for one thing, they are not endangered. Indeed, they are proliferating as drought and overgrazing is increasing the amount of dry, desolate rangeland that they prefer. The bore holes provided for livestock have both boosted their populations and afforded a place where these wide-ranging birds can be easily captured. When nesting, sand grouse are highly vulnerable to foxes, jackals, mongooses, and other predators. Protection of the nesting sites may be the key to maintaining their populations if harvesting schemes are introduced.

TRUMPETERS

Trumpeters (Psophia species) might prove to be a useful species for sustainable production within tropical forests. As "tree poultry," these relatives of cranes could help provide meat without destroying the trees, as is now done to raise cattle.

These chicken-sized birds inhabit South America's jungles.16 They are nonmigrating, ground-dwelling, and are often kept as pets, notably by Amerindians. Under human protection, trumpeters become very tame. They recognize strangers and challenge them with a loud cackle. 17

Fully adapted to the forest environment, they can run fast, but fly poorly. In the wild, this makes them easy targets for hunters. Because of this and the fact that they make excellent eating, they are approaching extinction in some areas.

No attempts have been made to rear these birds in numbers, but this should be tried. They feed mainly on plant materials, particularly berries of all kinds. They also relish grasshoppers, spiders, and centipedes, and are particularly fond of termites.

Trumpeters require trees; they completely avoid cultivated land. Thus, as the destruction of forests in South America continues, their habitat is shrinking. Although their existence is not as yet threatened, the long-term prognosis is bleak. If managed in "forest-ranching" programs, however, they might be saved from extinction and thriving populations built up.

Interest in rabbits continues to increase. It is now widely recognized that the raising of small animals in developing countries has great potential as a means of improving human nutrition and economic security. The famines in Africa, Latin America, and Southeast Asia starkly illuminate the need for maximum efficiency in food production to maintain the quality of human life. Rabbit raising contributes to meeting these needs.
P.R. Cheeke, N.M. Patton, S.D. Lukefahr, and J.I. McNitt Rabbit Production

Rabbits are especially well adapted to backyard rearing systems in which capital and fodder resources are usually limiting factors in animal production. When rabbits are reared according to the techniques appropriate to the environment they can do much to improve the family diet of many of the most needy rural

families, while at the same time supplying them with a source of income. With more advanced technology rabbit production can also help to supply big city meat markets.

Food and Agriculture Organization The Rabbit: Husbandry, Health, and Production

FIGURE