First international seminar on farming of invertebrates and other minilivestock.

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Keywords: Minilivestock — Tropical snails — Insects — Manureworms — Butterfly farming.

Summary

At this Seminar, held in the Philippines, minilivestock was defined as small-animal species, used as food, feed or source of revenue in given parts of the world, usually ignored by scientists trained in industrialized countries, but very suitable and promising for small producers.

The biology and use of tropical land and water snails and of manureworms, as well as different aspects of insect farming and use of insects for sericulture, food, feed or for collectors, were discussed. Sociological and extension problems connected with rural development were considered. Recent experiences of butterfly farming, tropical snail farming, use of termites and the raising of cricetoma or guinea pig for meat production were also reported. Conclusions and recommendations were drafted concerning terminology, sociological aspects, animal requirements and research, education and training needs.

Minilivestock appears as a challenging new branch of animal production that offers a considerable potential for rural development, but calls for further experimental work for the optimization of production systems.

Résumé

Le premier séminaire international sur l'élevage des invertébrés et le mini-élevage a eu lieu aux Philippines. Sous le terme mini-élevage on regroupe l'exploitation, à des fins alimentaires (pour l'homme ou le bétail) ou économiques, d'espèces d'animaux de petite taille, mal connus des scientifiques des pays industrialisés, mais très indiqués pour les petites exploitations, même péri-urbaines.

La biologie et l'exploitation d'escargots tropicaux terrestres et aquatiques, de vers de terreau et de différents insectes ont été présentées et illustrées ainsi que des aspects concernant la sociologie et la vulgarisation pour le développement rural. Des expériences récentes de fermes à papillons, d'élevage d'escargots tropicaux, d'exploitation de termites ou d'élevage de cricétomes et de cobayes pour la production de viande ont aussi été exposées et discutées.

Des conclusions et recommandations ont été rédigées concernant la terminologie, les aspects sociologiques et les nécessités de la recherche, de l'enseignement et de la formation dans le domaine du mini-élevage.

Le mini-élevage semble être une nouvelle et prometteuse branche de la production animale qui offre un potentiel considérable pour le développement rural, mais nécessite encore de l'expérimentation pour l'optimisation des différents systèmes de production.

Introduction

The first international seminar on the farming of invertebrates and other minilivestock was held from November 18 to 29, 1992 at Cresta del Mar Hotel in Bauang, La Union, in the Philippines. The seminar was organized by Prof. Jacques Hardouin of the Institute of Tropical Medicine, Antwerp (Belgium) and co-organized by Dr. Patricia M. Barcelo of the Don Mariano Marcos Memorial State University, Bacnotan (Philippines). Support for the meeting was provided by the Commission of the European Communities (DGXII, STD-2), the International Foundation for Science and the Technical Center for Agricultural and Rural Cooperation.

Some 35 scientists from Belgium, Benin, Cameroon, France (La Réunion), Germany, Italy, Ivory Coast, Nigeria, Morocco, Papua New Guinea, the Philippines and Zaire were present.

The topic of the seminar was introduced by Prof. J. Hardouin, with an opening lecture on the place and prospects of minilivestock in rural development, and by Dr. P.M. Barcelo, with a paper on microlivestock as food and feed in the Philippines.

During the following sessions lectures were given on the biology and use of silkworms, land and water snails, manureworms and maggots and on different aspects of insect farming, with particular regard to butterfly farming. Invited lectures were also given by J. Barcelo, on sociological aspects, and by F. Dumlao, on extension problems.

Participants reported on their recent experiences of snail farming in different African countries (Benin, Ivory Coast, Morocco, Nigeria), of use of termites as feed (Zaire) and of raising cricetoma (Zaire) and guinea pigs for meat production (Cameroon and Italy).

Field visits were made to an earthworm research area and to a silkworm center at the Agro-forestry Campus of the Don Mariano Marcos Memorial State University in Bacnotan, to a farm in Ilocos Norte, to the Don Severino Agricultural College in Idang and to the International Rice Research Institute in Los Banos.

The Proceedings of the Seminar will be available at the Institute of Tropical Medicine, Antwerp (Belgium).

A brief summary of the main topics discussed at the seminar is given below.

Minilivestock and rural development

In the opening lecture on «The Place of minilivestock in development to-day and to-morrow», J. Hardouin (Belgium)

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explained that by minilivestock he means small-animal species used as food, feed or source of revenue in given parts of the world but usually unknown to animal production specialists trained in industrialized countries, and often officially ignored also by the Livestock services of their home areas, even though their meat, often considered bush-meat or game-meat, may be appreciated and command a higher price than that of more conventional animals. The term minilivestock should be preferred to «microlivestock» coined for this branch of animal production by Vietmeyer around 1984 and more appropriately indicative of animals of microscopic size.

Amongst minilivestock species, Hardouin listed several edible rodents (the grass-cutter or aulacode, the Gambian rat or cricetoma, the ground squirrel, the capybara, the agouti, the hutia, the mara, the paca, the guinea pig), some insectivores (*Tenrec ecaudatus, Setifer setosus*), snakes, lizards, frogs and invertebrates such as snails, earth- and manureworms and various insects. Some of these species are still captured in the wild, but for most of them it is possible to organize fully controlled production systems that could be particularly suitable for back-yard production, even in peri-urban areas, or for small producers, unable to afford major investments. In many cases minilivestock production can be based on the use of by-products and wastes and may be optimally combined with a plant production system.

A large demand for minilivestock products already exists and the animals are fully adapted to the environment. The introduction of minilivestock farming, besides providing animal proteins as food or feed or generating income, may also alleviate the pressure of gatherers and poachers on the environment. For optimization of minilivestock production systems, some aplied research, a better knowledge of health aspects (parasitic and infectious diseases of minilivestock and zoonoses) and extension work are still required. This is a new and promising approach to animal production, based on sustainability, protection of the environment and rational use of local species. It has received some support from international organizations (IFS, CTA and FAO) and provides challenging opportunities for both scientists and developers.

Tropical landsnails

African giant landsnails are collected and marketed in many West-African forest areas, where they provide an excellent and very popular food for rural and urban populations. In order to meet the increasing demand for snail meat and to reduce the harvesting pressure on wild snails, pilot snail farms have been developed.

C. Stiévenart (Belgium) presented a review on the biology of some *Achatinidae*, known as edible snails, with emphasis on aspects most relevant for snail farming, such as the nutrition, reproduction, growth and adaptability to environment of these animals which, unlike conventional livestock, are cold-blooded, have an external skeleton (the shell) and can survive without food or water during dry periods (aestivation).

The feed preferences of these herbivores were described as well as their important calcium requirements. As to the reproduction of these hermaphrodites, usually oviparous, opinions still differ with regard to the possibility of self- or cross-fertilization; age of sexual maturity varies from a minimum 3.5 months in *Limnicolaria flammea* to a maximum of 2 years in *Achatina achatina*; ellipsoidal shaped eggs, of different size and in small or large clutches according to the species, are laid in underground holes for natural incubation; the gestation and incubation periods are very variable. Sometimes eggs are laid shortly before hatching. The life span of experimental snails ranges from 5 to 10 years according to the species.
Specific shell wall formation during growth was described, as the live weight of these molluscs is closely related to the hydration stage, shell length should also be considered when monitoring snail growth.

As to adaptability to the environment, in the case of *A. achatina* various artificial photoperiods influenced the growth but not the reproductive capacity: in excessively dry climatic conditions snails survive by aestivation, with reduction of flesh weight, which is in part quickly recovered on contact with free-water; aestivation increases the gestation length. Response to shell traumatism was described and appropriate husbandry techniques, to avoid shell damage and depress

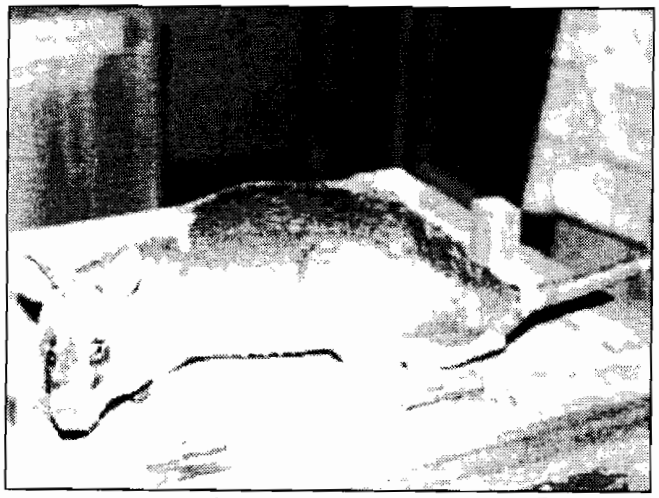

Photo 1 — Cricetoma *(Cricetomys gambianus)* in captivity in Zaire, weight ± 1.3 kg (Photo M. Malekani)

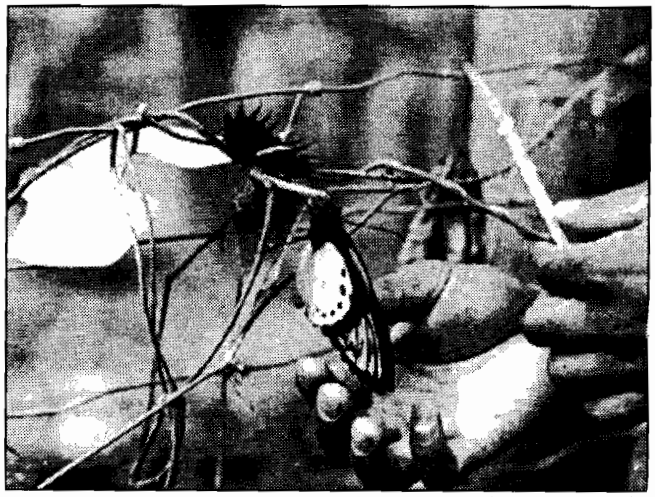

Photo 2 — *Ornithoptera priamus poseidon* — larva and adult on *Aristolochia tagala* (Photo P. Clark)

growth rate, were suggested.

In a further lecture C. Stiévenart (Belgium) reported on the use of the giant African snail as feed or food: a review was given of recent data on body composition, nutritive value and aminoacid content (limited contents of methionine and cystine) of *Achatinid* snails, as well as on the use of whole giant African snails, or of the parts not eaten by man (shell and viscera), in diets for broilers, layers and swine. It was reported that feeding snail meat leads to a growth depression which is inhibited by boiling snails for 15 to 20 minutes prior to processing.

Recent experiences on snail farming in different African countries were reported by the participants invited to the seminar. D. Adama (Ivory Coast) reported on the SODEPRA experience of snail farming and on plans for snail pasture farming and to test snail meal in feeds for pigs. K. Benabdeljelil (Morocco) reported on the Moroccan situation, the snail species existing in that country, their use as food, the trading system and the export potential. J.T. Codjia (Benin) illustrated his observations on feeding, mating and on other aspects of behaviour of *Achatina* spp. and *Archachatina marginata* in captivity. E.A. Imevbore (Nigeria) reviewed recent research work carried out in Nigeria on different aspects of snail production and considered future possibilities in this field.

Water snails

Fresh water snails originating from the Amazon River basin and also established in Florida were introduced and propagated in the Philippines in the early 1980's as a means of increasing the availability of a cheap and excellent source of protein for humans and livestock, and with an eye to possible export markets for «escargots». Due to their reproduction and growth rates, faster than the native snail (*Pila Luzonica*), and to the lack of natural predators, the imported snails escaped from artificial ponds and rapidly proliferated in moving bodies of water and in rice fields where they displaced the native snails and, by 1986, had become a rice pest.

In the Philippines these exotic snails are known as golden «kuhol» or golden miracle snails or giant freshwater snails or golden apple snails, because they can grow to apple size. Some confusion exists with regard to their identification and nomenclature, possibly due to the presence of different species, but the most common scientific name is *Pomacea canaculata,* Lamarck.

This and a lot of other information concerning the «golden snail» was given in lectures by P.M. Barcelo (Philippines) on some aspects of the biology, ecology and culture of the golden apple snail and on the use of the golden snail as food and feed, and by J. Datuin (Philippines) who presented a very well documented paper on research and development of the golden snail in the Philippines.

It was pointed out that this amphibian mollusc reaches sexual maturity at 2 months from hatching and continues to grow to a size of 7 cm or more, in 5-7 months. The sexes may be distinguished by the shape of the operculum. Pink coloured clusters of 50 to 300 eggs are laid at the side of ponds or in standing crops or on any object above the water surface. Each snail can produce 1000-1200 eggs in one month, with 80% hatchability, and has a life span of from 2 to 5 years. After a variable incubation period, hatchlings drop into the water, become voracious eaters and feed on leaves of a wide range of submerged plants. When water drains away they bury themselves in mud and, sleeping hidden in dry soil, may live for over 6 months. In the rice fields they feed on young rice seedlings and, due to their fast reproduction and growth potential, may turn into a dreadful pest. In the Philippines the golden snail was first reported as a rice pest in 1986 and at present is considered the most alarming pest for irrigated rice.

The golden snail problem in rice fields has led to the testing of different control methods, based on chemical (molluscicides), biological (botanical pesticides or herding of ducks) and mechanical methods (hand removal of snails, use of wire mesh screens, crushing of egg clusters) or on modified water management practices and integrated pest management technology.

As far as golden snail farming is concerned, interesting results were reported of some experimental trials aimed at comparing feed efficiency of several feeding media or of different management techniques, such as stocking density or water depth or flow rate in rearing ponds. Snails were efficiently fed on palawan (*Crystosperma merkusii*), azolla (*Azolla pinnata*) or sweet potato (*Ipomoea batatas*) leaves (with a conversion efficiency of 4.5 kg in the case of this last). Feed efficiency and growth rate decreased with increasing snail density, but the inhibiting effect of crowding could be reduced by using running instead of stagnant water.

The nutrient composition of this mollusc was reported: it is low in calories, but remarkably rich in protein. Several suggestions and recipes were given for food preparations, as well as the results of some acceptability trials and of palatability tests with golden snails grown on different diets. However, whilst the native snail is a popular and favourite food item, the local population apparently considers golden snails a poor man's meat.

This mollusc may also be used as feed, replacing expensive imported feed ingredients. It can be fed to livestock as whole snail meal (either cooked or uncooked), as snail meat meal or as snail shell meal. Positive results were reported of comparative feeding trials where golden apple snail meal was used either as a substitute or as a supplement to fish meal for broilers, or as a supplement in diets for growing native chickens, for brooding male mallard ducks, for laying ducks or for finishing hogs. In broilers better performances were obtained with cooked golden snail meal than with raw meal. Golden snails gave good results when fed to Nile tilapia or to prawns and are under consideration as a feed for shrimps and crabs; their culture could be integrated with duck, pig and pigeon raising.

Insects

Insects are collected or farmed by man for production of textile fibre, as a source of food or feed, as specimens for collectors, for the art trade and for insectariums.

Sericulture is a traditional and successful rural agro-industry long established in many parts of the world. It is a specialized form of insect farming, where the rearing of the mulberry silkworm (*Bombyx mori,* L.) is part of an integrated activity which includes mulberry leaf production, silkworm egg and

cocoon production, silk yarn processing and weaving. The main biological facts concerning silkworm rearing and the different aspects of sericulture were illustrated by V.M. Libunao (Philippines).
Unconventional and recent developments in insect farming were presented by two specialists working in Papua New Guinea: P. Clark and C.W.L. Mercer, with three lectures followed by a round table.

C.W.L. Mercer (Papua New Guinea) presented a paper on «Insects as food in Papua New Guinea», with an historical review of the use of insects in human nutrition, with examples referring to the early man, Biblical, Greek and Roman times and the author's experience in Malawi, Sarawak and Papua New Guinea. Fourteen species of insects currently caught and eaten in this last country were described, and more detailed information was given concerning the sago weevil grub (*Rhynchophorus ferrugineus papuanus*), the consumption of which is widespread in some areas of Papua New Guinea. This sago grub is about 5 cm in length, cream in colour and breeds in the rotting pith of the sago palm (*Metroxylon* spp.) and is thus a by-product of sago palm, which is «harvested» for collection of the sago starch, a staple food in part of the country. Information was also given on the marketing and cooking of sago grubs and on their nutritional value. Eating of sago grubs is reported to alleviate the protein deficiency of a human diet mainly based on sago starch.

Local recipes from Reunion for cooking larvae of wasps (*Polistes hebraeus*) were presented by C. Briard (Reunion).

P. Clark (Papua New Guinea), in his lecture on «Organization and Economics of Insect Farming», reported that since the old days of a few enthusiastic insect «hunters» and collectors, an industry has developed as a result of the expanding world market for insects as specimens for collectors or for the art trade and, recently, also for the «live trade», with the selling of pupae for simulated tropical exhibits, i.e. insectariums or butterfly houses.

To cope with this growing demand, insects may be collected, farmed or ranched (this term is used when insects are only taken into captivity just before emergence) mainly in tropical countries. If organized at village level, this activity may represent an appropriate, environmentally sound and viable enterprise, providing employment in rural areas and, if included in the rainforest utilization concept, perhaps providing an alternative to logging.

Several guidelines were given on how to organize and operate an insect industry on a national scale; being a wildlife related business, this requires the combined involvement of private enterprise and government. The lecturer gave details of how the Insect Farming and Trading Agency (I.F.T.A.), that he presently manages, operates in Papua New Guinea. This insect farming business, initiated in 1978 by the government, is now operated through an essentially non profit self funding agency, owned by the University of Technology of Papua New Guinea, and is responsible for the training of collectors/farmers and for the marketing of insects coming from over six hundred village people throughout the country.

«A Butterfly ranching trial in Papua New Guinea» was described by C.W.L. Mercer (Papua New Guinea). This is the case of a small scale butterfly ranch, of 0.3 hectares, established in 1991 in a semi-urban environment, through a process of «habitat creation», at the University of Technology of Papua New Guinea. It was decided to ranch six species of butterflies, all of the *Papilionidae* family. The trial area was delimited by a fence and, during most of 1991, appropriate trees and vines, most of them from the rainforest area, were chosen and planted as larval foodplants as well as nectar sources for the adult butterflies and primary attractants to the trial area.

Since February 1992, a weekly census of the population of butterflies in the trial area has been carried out, with enumeration of eggs, caterpillars, pupae and adults on each individually identified foodplant.

The butterfly ranching trial has not yet reached full production, but, according to the lecturer, a probable income of over 1000 US $ per year is anticipated for the sale of dead butterflies. This could be increased ten-fold by the «live trade» of pupae for the butterfly houses overseas. Butterfly ranching was described as a challenging possibility for promoting rural development by managing biodiversity in «an environmentally friendly and conservationally acceptable» way. The various difficulties were also described.

A more conventional use of insects concerns termites captured for use as food, feed or bait. Two notes were presented on this topic: one by M. Mathe (Zaire) on «Village techniques for capturing termites as practiced by the Ngombe of Lisala» and one by J. Hardouin (Belgium) on a very simple technique adopted in Togo to harvest termites periodically from an active termitary in order to provide feed for village poultry.

J. Hardouin also gave information on a trial performed in Burkina Faso for the production of maggots of an unspecified fly («mouche à viande») on different by-products (rumen content, pig manure, blood, traditional and industrial brewery draff and bran). Maggots were cropped at day 4 or 5; their high protein content makes them a valuable feed for poultry.

Manureworms

Manureworms are the Epigeic species of earthworms (*Annelida* or annulate worms of the class *Oligochaeta*) that grow and multiply by eating organic matter in aerobic decomposition. Compared with other ecological categories of earthworms, manureworms have a higher reproduction rate and are thus of greater interest for vermiculture. Different species of manureworms may be used for the production of vermicompost, a useful way to improve soil quality, or of a high value feed, for use in animal production, particularly as a protein source for monogastric animals.

A lecture on «Biology and production of manureworms» was given by A. Vorsters (Belgium), with a lot of interesting background information on the main external and internal characteristics, reproduction, locomotion and movement, feeding, growth and ecology of earthworms. Experimental results were reported of production trials with *Eudrilus eugeniae*, a manureworm indigenous to West-Africa. On a rearing substrate consisting of commercial garden compost and rabbit droppings, four different worm densities (10, 30, 50 and 72 hatchlings per recipient) were compared by perio-

dically measuring the individual worm weight and the total worm biomass. The lowest tested density gave the fastest individual weight gain (about 2 g weight at day 50) and the earliest sexual maturity. The highest worm biomass (about 30 g at day 50) was obtained at the second lowest density tested. Parameters for the calculation of the optimal density were given. A second comparative trial confirmed that the density had a greater influence than the feeding programme on weight gain and on cocoon production of *Eudrilus eugeniae*.

On the basis of this experimental work a practical system for manureworm production was set up. The necessary infrastructure and the management techniques were described as well as the first results obtained at the Projet Songhai in Porto Novo (Benin), with *Eudrilus eugeniae* and *Eisenia fetida* on a substrate of cow dung.

In a second lecture A. Vorsters (Belgium) reviewed available information on the «Use of manureworms as feed» and provided several data on nutritive value and amino acid composition of manureworms and on the advantages and disadvantages of their use as feed, as well as some results of feed trials where earthworms were used as a protein source for village pigs in Papua New Guinea or for *Tilapia nilotica* or Japanese Quails (*Coturnix coturnix*) or broilers in the Philippines.

Other minilivestock

Brief information was also given on two minilivestock species that are mostly captured in the wild, are much appreciated for their meat and whose potential as farm animals is under investigation: the cricetoma and the tenrec, and on one minilivestock species, the guinea pig, which was domesticated in prehistoric times and is reared for meat production in many parts of the world. The three species belong to the vertebrates.

M. Malekani (Zaire) presented a brief report on his experience of capturing and rearing «cricetoma» (*Cricetomys gambianus*) in captivity. Notwithstanding some taboos, the meat of this giant rat is consumed by people of central Africa either fresh, smoked or salted and, particularly as smoked meat, is considered a delicacy and is presently in high demand.

C. Briard (Réunion) reported on the *Tenrec ecaudatus*, an insect and worm eating mammal, endemic in Madagascar and the Comores and introduced to the Seychelles, Mauritius and Reunion where it is hunted and poached for his meat (a recipe was also presented). It can reach 40 cm in size, gives birth to litters of 12-15 and, in captivity, has been fed on meat and bananas.

With regard to the guinea pig, a coordinated research programme was set up in Cameroon and Italy: J.D. Ngou Ngoupayou (Cameroon) presented preliminary results of the survey and monitoring programme in course in Cameroon of guinea pig raising in the peri-urban area of Yaoundé and of an in station breeding and feeding trial; M. Cicogna (Italy) briefly reported the preliminary data on performances obtained in a guinea pig experimental colony established in order to compare two breeding systems (inbreeding vs. outbreeding) and two mating rhythms (planned vs. unplanned) and to study feed utilization in this animal.

Conclusions and recommendations

With a very positive attitude and active participation of all the scientists attending the meeting, one full day was reserved for a general discussion and to draft the Seminar's conclusions and recommendations, with due consideration of aspects concerning terminology, sociology, animal requirements, research, education and training needs.

In particular the seminar recommended the adoption of the term «minilivestock» and provided some definitions of this new branch of animal production.

The needs of further applied and adaptive research on little known species and on particular aspects of animal production or health, of a wider exchange of information on minilivestock and the advisability of introducing the existing knowledge on minilivestock into the curricula of the education system were particularly emphasized.

As a means for the dissemination of new information on minilivestock the seminar recommended the promotion of further regional/international meetings and the adoption of the semestrial bulletin of B.E.D.I.M. (Bureau for Exchange and Distribution of Information on Microlivestock), supported by F.A.O. and produced and distributed by ACP-EEC C.T.A. (Wageningen) under the coordination of Prof. J. Hardouin (I.M.T. Prince Léopold, Antwerp).

The information collected at the seminar indicates that minilivestock, and invertebrate farming in particular, may be considered a challenging new branch of animal production of considerable value for rural development, but that further research and experimental work is required for the optimization of the production systems.

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