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Prevalence of *Ariophantid* and *Helicarionid* gastropod mollusks in pastures for sheep at Mannavanur, Palani hill ranges, Tamil Nadu, India

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Abstract

Southern Regional Research Centre (SRRC), a regional centre of ICAR- Central Sheep and Wool Research Institute (ICAR-CSWRI), at Mannavanur, Tamil Nadu, maintains synthetic breeds of Sheep (Bharat Merino and Avikalin) and broiler rabbits (major breeds- White Giant and Soviet Chinchilla). Sheep are accompanied by graziers into the pasture area nearby reserve forest and they noticed some snails and slugs are crawling in the pasture area of sheep. These specimens were collected by graziers during September 2018 and July 2020 from the pasture area. Three species of gastropods were identified as *Mariaella beddomei*, *Pseudaustenia atra* and *Ariophanta basileus*. Effect of the usage on the ideal control methods of these molluscan species, restriction of sheep grazing in the pasture area during the rainy seasons, vector potential of these molluscan species in the spread of Dicrocoeliosis and lung worm infections among sheep and Periodical deworming of both sheep & rabbits using the suitable anthelmintics were dealt.

Keywords: *Ariophanta basileus*, Helminthiasis, *Mariaella beddomei*, *Pseudaustenia atra*, Sheep

Introduction

In animal kingdom, mollusks are broadly known for their second largest phylum and major contribution in the population of fauna at global level ^[1]. Among the classes within the phylum *Mollusca*, *Gastropoda* (which includes Snails and Slugs) is the only class having both terrestrial and aquatic adaptation. Ramzy ^[2] described that snails are the gastropods having calcareous shells, whereas slugs are the gastropods without shell.

Gastropod mollusks (including snails and slugs) are well known for their vector potential in the transmission of trematode infections among ruminants ^[3] and nematode infections in a wide range of mammalian species as well ^[4].

In addition to veterinary importance, snails are also involved in the transmission of trematodes of medical importance ^[5].

Grewal and his team ^[4] briefly described the various types of associations between nematodes and molluscs, list the known species of nematodes associated with molluscs along with their specific hosts, and discusses evolutionary trends in mollusc parasitism. Some nematode species use slugs and snails as intermediate hosts in which some part of the nematode life cycle is completed and the host is killed. The nematodes that form this kind of association with the slugs and snails occur in the orders *Strongylida*, *Oxyurida*, and *Rhabditida*. Members of *Angiostomidae* (Order, *Rhabditida*) are parasites of amphibians and reptiles but use snails and slugs as obligatory intermediate hosts. In the second type of association with the definitive mollusc host, the entire nematode life cycle is completed inside the host, but the nematodes are not pathogenic and do not kill the host. In the third kind of association, the entire nematode life cycle is completed in the definitive mollusc host and the nematodes are pathogenic, causing host mortality. *Daubaylia potomaca*, *Pellioiditis pelloides* (= *Rhabditis oncomellaniae*), *Phasmarhabditis hermaphrodita*, *P.papillosa*, and *P.neopapillosa* form this kind of association with their mollusc hosts.

While doing the review of literature, it is found that the information on diversity and distribution of land and freshwater mollusks of Tamil Nadu is scattered and particularly it is lacking behind in case of protected areas is always wanting.

Non-Marine Mollusca of Madras and its vicinity was first reported by Ramanan^[6] followed by Hornell^[7, 8]. Satyamurthy^[9] gave details of 122 species of gastropods in his major study on the land and freshwater Mollusca in the collection of Madras government Museum. Jayaram and his team^[10] listed the gastropods from the Cauvery river system. Anantharaman and his team^[11] recorded 16 freshwater gastropods. Veerappan^[12] in his study recorded 18 freshwater gastropods. Mavinkuruvu and his team^[13] reported the check list of 208 species (excluding varieties) from Tamil Nadu. A total of 32 species of freshwater gastropods belonging to 16 genera and 10 families are reported from Tamil Nadu^[14]. Rajan and his team^[15] reported under 17 species of 10 genera 7 families 2 order and two sub classes of freshwater Gastropods from Porur Lake, Chennai. Santhiya and his team^[16] recorded a total of 11 species of molluscs from Lower Anaicut Reservoir of Tamil Nadu. Among them, 7 species were gastropods belonging 1 order, 3 families, 6 genera while 4 species were bivalves under 2 orders, 2 families and 1 genus. Soundararajan and his team^[17] enumerated a total of 31 species under 14 genera from 2 agro-climatic zones of Tamil Nadu viz., North-eastern (Kancheepuram and Vellore) and hilly zone (The Nilgiris).

In India, the land snails are acting as the intermediate host for the lancet fluke infection, i.e., *Dicrocoelium dentriticum* among sheep of north-west Himalayan region^[18] and terrestrial gastropod mollusks including snails and slugs are the potential intermediate hosts for the lung worm infections, i.e., *Muellerius sp.*, in sheep^[19, 20], goats^[20], spotted deer^[21] and *Protostrongylus sp.* in Rabbits^[22].

One of the regional centres of ICAR-Central Sheep and Wool Research Institute (ICAR-CSWRI), commonly known as Southern Regional Research Centre (SRRC), is located at Mannavanur, about 32 kms away from Kodaikanal town and this Kodaikanal is present within Palani Hill ranges of Tamil Nadu, India. SRRC is maintaining synthetic breeds of Sheep (Bharat Merino and Avikalin) broiler rabbits (major breeds- White Giant and Soviet Chinchilla) as well^[23].

At SRRC, semi intensive and intensive systems of management are being followed for sheep and rabbits, respectively. On Everyday morning, Sheep are accompanied by graziers into the pasture area nearby reserve forest area and taken back to sheds in the evening around 5pm. During the rainy days of grazing, graziers noticed that some snails and slugs are crawling in the pasture area of sheep.

Increasing awareness on the importance of biological diversity and environment conservation, for the future of mankind, it has become necessary to estimate the resource available and to understand the structural and functional significance of the species. The need for a stronger focus on invertebrate conservation has long been organized, but the information on the status and distribution of them are not readily available. It is in this context an attempt was made to collect and collate the information on Prevalence of *Ariophantid* and *Helicarionid* Gastropod Mollusks in pastures for sheep at Mannavanur, Palani Hill ranges, Tamil Nadu, India.

Materials and methods

Area of the study

The present inventory on land mollusks was carried out in Mannavanur is a farming village containing about 1500 families coming under Dindigul district, Tamil Nadu, India. Mannavanur is one of the most important tourist centres of

Kodaikanal, having Southern Regional Research Centre (ICAR-CSWRI), and is situated about 35 kms away in the west direction from Kodaikanal at an altitude of 2030 metres. The Coordinates for this farming village are 10°12'45"N and 77°20'38"E, to fill the gap on biodiversity information from such geographical areas in term of malaco faunal diversity. The present study is based on a time constrained field surveys.

Field Sampling

Visual encounter search survey method was used for mollusca in the aquatic and terrestrial habitats^[24]. The land mollusca from the field sites were collected from different field gazettes during the rainy seasons (September 2018 & July 2020). Appliances viz. forceps, rubber gloves, polythene bags and plastic containers were used for proper collection and safe keeping of the specimens. All the possible macro habitats of the land snails viz. rotten woods, leaves, trunks, leaf litter, barks of the tree, stone and concrete surface, under forest debris and possible humid areas where the maximum possible availability of land snails, were surveyed physically. At least one living individual or dead shell of each species was collected as voucher specimen and was brought to the laboratory either in wet or dry conditions. The living shells were collected and narcotised, thoroughly washed to remove mucous, and then treated with ascending grade of spirit (20%, 40%, and 60%) and preserved in 70% ethyl alcohol in the field itself and brought back to the laboratory for identification. Identification of the gastropod mollusks in the present study was done by the experts at Southern Regional Centre, Zoological Survey of India, Chennai, Tamil Nadu, India

Identification of Gastropod mollusks

Morphological examination of the shell was carried out with the help of magnifying glass (10 x) or under a binocular microscope. All the measurements are given in millimeters (mm). For each species, largest and smallest were selected for measurements. Shell measurements are given in terms of maximum dimension along the longitudinal axis (Length= L) maximum dimension along body whorl (Diameter =Width) and the maximum length of the aperture (Aperture length= APL). All the measurements were taken with the help of a dial calliper. In the descriptive part the usual procedure employed by Malacologist is followed for the sake of uniformity. For land mollusca, identification and classification as suggested by earlier were followed^[25, 26, 27]. The systematic arrangement of genera and species is mainly based on the keys described in Vaught's classification (1989) & Bouchet and Rocroi^[28]. After identification of the specimens were deposited in the National Zoological Collection (NZC) Zoological Survey of India, Southern Regional Centre, Chennai, India.

Results

The specimens collected by the graziers were identified as *Mariaella beddomei* (Godwin-Austen, 1888)^[29] *Pseudaustenia atra* (Godwin-Austen, 1888)^[29] and *Ariophanta basileus* (Benson, 1861)^[30].

Mariaella beddomei (Fig- 1) is a species of air breathing land slug under family *Ariophantidae* of class Gastropoda. This species can be identified with the following diagnostic characters. Shell thin, convex, ovate, whitish and somewhat

variable in form, membranaceous and translucent on the margin. Animal is fairly large, pale yellowish brown, olivaceous green or olivaceous brown, occasionally bluish black, and generally mottled with dark blotches. The sole of the foot broad, smooth and velvety; sides of the foot are finely papillate and feebly and irregularly furrowed. Foot broad and truncate in front, and rather narrow and obtusely pointed behind. The mantle bears two narrow, raised ridges on the shell lobes, one extending from the shell aperture round the left margin of the shell and the other towards the respiratory orifice on the right margin. The tentacles are seen as short, stubby and cylindrical structures, projecting out from beneath the front edge of the mantle shield.

Distribution: Kerala, Karnataka, Maharashtra, Tamil Nadu
Elsewhere: Sri Lanka

Conservation Status: Not common.

Pseudautestia atra (Fig-2) is also a species of air breathing land slug under family *Helicarionidae* of class *Gastropoda*. This species can be identified with the following diagnostic characters. Shell very thin, ovate, rather ear-shaped, slightly convex above, concave interiorly, smooth, greenish, the membranaceous epidermis of the shell extends beyond the peristome considerably; whorls 1½, apex almost flat. Animal long, narrow, shell lobes partly covering the shell, dorsal surface of foot behind the shell flattened and divided anteriorly into two distinct lappets, on both sides of the shell.

Distribution: India: South Indian Hill (Kerala, Tamil Nadu).

Conservation Status: Not common.

Ariophanta basileus (Fig- 3) is a species of air breathing land snail under family *Ariophantidae* of class *Gastropoda*. This species can be identified with the following diagnostic characters. Shell narrowly umbilicated, conoidly depressed, covered with a brownish-yellow deciduous epidermis, beneath the epidermis white, pinkish towards the apex, surrounded beneath the periphery by a broad dark chestnut or blackish band, which is paler below; sculpture consisting of striae covered by a few impressed spiral lines and of irregular, shallow, slightly oblique grooves, obsolete; spire conoid, apex obtuse, suture scarcely impressed; whorls 5, flat, the last not descending, convex beneath, angulate at the periphery; aperture oblique, ovally lunate; peristome thin, straight, columellar margin expanded and briefly reflexed, partly covering the umbilicus.

Distribution: Tamil Nadu, Kerala

Conservation status: Endemic to the Western Ghats.

Discussion

The present study is aimed to find out the diversity of mollusks crawling in the pasture area of sheep at SRRC, Mannavanur. Study area is a subtemperate region in Palani Hill ranges of Tamil Nadu, located about 2030 metres above mean sea level and is extensively known for its annual rainfall of 1055 mm throughout the year. The pasture area of sheep is having grass species such as Kikuyu (*Pennisetum clandestinum*) and speargrass (*Heteropogon contortus*). Apart from these grass species, the grazing area is infested with weeds and shrubs such as Mexican poppy, common lantana and pteridophytes such as ferns [23]. Further, a lake is presented adjacent to the pasture area (Fig.4). In addition to sheep, common livestock species of the village, Cattle, buffaloes, and wild animals, including Red dogs, Deer, Wild boar and Hares, are getting benefitted by the water of this

lake.

Further, the Palani Hill ranges and the Nilgiris are serving as the type locality for most of the endemic species of gastropod mollusks and are therefore popularly described as “Mega molluscan diversity centres” among the Indian Malacologists [13]. Southern Regional Research Centre (SRRC), Mannavanur, Kodaikanal is blessed with “Mega molluscan diversity centres”, as it falls under Palani hills range. Since this is the first attempt to ascertain the status of gastropod molluscs from the study area, it may also yield handy number of species when more efforts are made from extended study area, such as riparian area. Ramaswamy and Arora [21] proposed that due to the survival of adult *Muellerius capillaris* for many years (over six years), the disease could be transmitted from one season to the next. Further, the first stage larva of *M. capillaris* is also hardy withstanding extremes of climates such as frost, snow, dry sunny periods or winds. In addition to these factors, the availability of potential molluscan vectors in the pasture areas shared by wild and domestic animals in India augments the chances for the spread of Muellieriasis. Foreyt and his team [31] concluded that when domestic goats and bighorn sheep share the common pasture land, the chances for the transmission of *M. capillaris* from goat to sheep is high. In the same way, the pasture area of sheep at SRRC, Mannavanur is also shared by cattle, buffaloes and horses further, the area of the present study is also having wild animals such as Indian Guar, Deer, Wild pig and red dogs [23]. Additionally, as per the previous reports, lymnaeid snails are the potential intermediate hosts for ovine fasciolosis in the Nilgiris, Tamil Nadu, India [32] and the lung worm, *Mullerius capillaris*, of sheep would utilize snails and slugs as intermediate hosts [4] (Grewal *et al.* 2003). Georgiev and Georgiev [33] validated the information that terrestrial gastropods would be acting as the intermediate hosts of Protostrongylid nematodes in pastures for sheep and goats in the region of Stara Zagora, Bulgaria. Taken together, the richness of wild fauna, ungulates including bovine species and the presence of diverse molluscan species in the pasture area of the present study could be a conducive factor for the high chances of trematode infections such as Dicrocoeliasis and nematodes of the superfamily, *Metastrongyloidea* (Order: *Strongylida*) among sheep at SRRC, Mannavanur. Dicrocoeliosis, caused by *Dicrocoelium spp.* (Trematoda, *Dicrocoeliidae*), commonly named “lancet fluke” or “small liver fluke”, is an economically important disease of grazing ruminants and could be zoonotic occasionally. The life cycle of this trematode involves two intermediate hosts (a terrestrial snail and an ant) [34].

Somvanshi and Kaul [35] reported that *Dicrocoelium dendriticum* is an economically important trematode infection in sheep and goats and is highly prevalent in hilly regions of India. As per the earlier report [36], it is observed that the exact species of land snail and ant involved as intermediate hosts needs to be studied in the transmission of *Dicrocoelium dendriticum* in India.

In the present study, the study area is having a land snail. i.e., *Ariophanta basileus* and is further of a hilly region. It is therefore speculated that *A. basileus* could be carrying the larvae of *D. dendriticum*. This needs an extensive investigation.

In India, Sharma and his team [22] reported a case of verminous pneumonia in a 3-year-old female rabbit at Charri, Himachal Pradesh. Based on the histopathological examination, the confirmatory diagnosis for the death of doe

is due to the infection by *Protostrongylus sp.* This lung worm of the rabbit utilizes the land snail (e.g. *Vallonia pulchella*) as the intermediate host. Similarly, in the present study, rabbits being maintained at SRRC, Mannavanur could also acquire the lung worm infection. This could be hypothesized as follows; the larvae of lung worms emerged out of gastropod mollusks, available in the grasses could be ingested by the rabbits since they have been fed with the grasses from the pasture area of sheep at SRRC, Mannavanur.

As per the experiments conducted by Lesage and his team [37], it is found that very few species of snail and slugs were refractory to infection by *Protostrongylidae*. In addition, Protostrongylid parasites, such as *Protostrongylus stilesi* (lungworm) is commonly observed in temperate latitudes among thornhorn sheep of Canada [38] and Bighorn sheep of North America [39].

Therefore, there could be the possibility of the transmission of Protostrongylid nematodes among sheep at SRRC, Mannavanur (subtemperate region) by the gastropod mollusks of the present study viz., *A. basileus*, *M. beddomei* and *P. atra*. This vector potential of the said three mollusc species in the transmission of lung worm infections of sheep warrants a detailed research work.



Fig 1: *Mariaella beddomei*



Fig 2: *Pseudautentia atra*



Fig 3: *Ariophanta basileus*



Fig 4: Pasture area of Sheep at SRRC, Mannavanur

Conclusions

Based on the above inferences, a detailed account on the life-history parameters of snails and slugs of Agri-horticultural importance, especially as food, is very much needed with a view to encourage or discourage the population build-up of these species, as the case may be. In India, the members of the families *Lymnaeidae* and *Planorbidae* are registered intermediate hosts of a number of helminth parasites which cause diseases in man and domestic animals. Of the terrestrial molluscs, the giant African land snail, *Achatina fulica* and the slug, *Laevicaulis alte* are known to cause serious damage to agri-horticultural plants. Besides, these land snails have also been registered as the intermediate hosts of the nematode parasite, *Angiostrongylus cantonensis*, causative agent of the disease, eosinophilic meningoencephalitis, both in man and monkey. As these diseases affect our socio-economy, attempts are being made to eradicate the same. On the other hand, to save the great loss to our agri-horticulture due to the attack of snails and slugs, malacologists are looking for an effective control measure. Reports on the successful rearing technique of medically and economically important molluscs are still wanting. Successful snail-host rearing method in laboratory is required in such basic studies as: snail-host-parasite relationships, population dynamics, effects of molluscicides, snail control method, among others.

Following recommendations are submitted for the future prospective studies.

1. Suitable strategies need to be devised for the control of gastropod molluscs.
2. Restricted grazing of sheep of SRRC, Mannavanur, in the pasture area during the rainy seasons should be followed in order to avoid the snail and slug borne helminthic infections among sheep.
3. Since *Ariophanta basileus* is a land snail, its vector potential in the transmission of Dicrocoeliasis among sheep and other livestock species needs to be studied.
4. Further, the *A. basileus*, *Mariaella beddomei* and *Pseudautentia atra* in the transmission of the lung worm infections such as Muelleriasis & Protostrongylosis, among sheep and other livestock species also need to be studied.
5. Periodical deworming of both sheep and rabbits at SRRC, Mannavanur should be carried out using the suitable anthelmintics.

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Compliance with ethical standards

Conflict of interest

The authors declare that he has no conflict of interest.

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