"Ectoparasites in Australian Waterfowl"

by

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Contents

	Page
-Acknowledgements	1
-Introduction	2
-Waterfowl in Australia	5
-Acari (Mites and Ticks)	11
-Phthiraptera (Lice)	18
-Siphonaptera (Fleas)	23
-The Hippoboscidae	24
-Materials and Methods	25
-Collecting ectoparasites from wings and feathers of ducks shot at Lake Buloke and Sale (Vic.).	26
-Trapping of Chestnut Teal (*Anas castanea*) and Grey Teal (*A.gibberifrons*) for ectoparasite search at Serendip (Victoria).	28
-Examination of nest-box material for the presence of ectoparasites in Serendip (Victoria).	31
-Results	33
-Survey of ectoparasites of Victorian waterfowl.	34
-Ectoparasites recorded from wild,trapped Chestnut Teal and Grey Teal at Serendip (Victoria).	35
-Examination of nest-box material for the presence of ectoparasites at Serendip (Vic.).	36
-Discussion	38

Page

-Tables and Figures 42

Table 1: Ectoparasite records for Australian waterfowl (Lavery,1971;Gaud,1974;Van Mourik,1981).

Table 2: Classification of Australian waterfowl (Frith,1977).

Table 3:Species composition of ducks examined on the opening day of the shooting season at Lake Buloke.

Table 4: Number of wings examined from ducks shot at Lake Buloke and distribution over the duck species.

Table 5: Host-parasite records for Victorian waterfowl.

Table 6: Numbers of Chestnut Teal and Grey Teal trapped and examined for ectoparasites at Serendip.

Table 7: Ectoparasite records for Chestnut Teal and Grey Teal.

Table 8: Ectoparasite records for Anas-representatives in North-America,Asia and The Netherlands.

Fig.1 : Division of the body of an acarid mite (Sheals,1973).

Fig.2 : Map of Serendip (Norman et.al.,1979).

-References 52

-Appendices 58

Appendix 1: The chaetotaxy of sarcoptiform feather mites (Acarina:Analgoidea),Atyeo,W.T;Gaud,J.(1966).

Appendix 2: Mites occurring on ducks,excluding the Freyanidae (Gaud,pers.comm.).

Appendix 3:Breeding attempts in Serendip during 1980-1981.

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Introduction.

Serious harm may be inflicted on animals by infestations of ectoparasites.Thus their irritating presence may affect the host lowering its resistance to disease,and skin lacerations caused by them may act as portals of entry for bacteria or viruses.Deplumation may result from presene of itch mites and blood-sucking mites and Mallophaga.Additionally animals may suffer seriously from anemia as a result of haematophagous parasites.Anemia in birds may,for example, be caused by ticks,blood-sucking mites,Mallophaga,fleas,hippoboscid flies or dipterous larvae.

Quite apart from direct effects,vertebrate ectoparasites are frequently vectors of disease-producing organisms,and as such may play an important proximate role in the modification of the population size of host species.Mosquitoes of the tribe Culicini are intermediate hosts for bird malaria.Mites may also transmit the bird protozoa Hepatozoon and Toxoplasma and the cholera-producing bacterium Pasteurella (Boyd,1951).

Ticks in particular have been reported as transmitters of many serious diseases involving protozoa,spirochaetes,rickettsia and viruses. Tick-borne diseases occurring in Australia include ,for example, "Q"-fever (Coxiella burnetti),tick"typhus" (Rickettsia australis) of man, anaplasmosis (Anaplasma marginale) and spirochaetosis (Borrelia gallinarum) of poultry (Roberts,1970).

Whilst there are no records of direct importance to waterfowl this does not indicate that ticks would not be of importance but merely illustrates the fact that little is known about ticks on waterfowl.

Additionally the evolution of ectoparasites on host-species may aid in the clarification of relationships between apparently related host-species.The flamingoes (Phoenicopteridae) provide the classical example.These birds are usuallly placed with the storks and herons (Ciconiiformes),more rarely with swans,geese and ducks (Anseriformes).The flamingoes are parasitized by species of three genera of feather lice (Anatoecus,Anaticola and Trinoton) which are found elsewhere only on the Anseriformes.The species parasitizing the Ciconiiformes,on the other hand,belong to different genera and are quite distinct from any found on the flamingoes or the Anseriformes. The most likely explanation of the presence of the duck-infesting genera on the flamingoes is that these genera were already established on an ancient Anseriformes-stock before it gave rise to the flamingoes on one hand and to the modern ducks,geese and swans on the other (Clay,1957).

Ectoparasites of birds have been well studied in Europe (e.g. Clay,1957),America (e.g. Broderson et.al.,1977;Malcomson,1960) and Asia (e.g. McClure and Ratanaworabhan,1973) but relatively little is known of the Australian ectoparasite burden carried by the avifauna and in particular waterfowl.Such data as are available were summarized by Lavery (1971) and are given in Table 1.

This report summarizes attempts made to identify parasite species present on Victorian waterfowl;to compare those present on the Chestnut Teal (Anas castanea) and Grey Teal (Anas gibberifrons), closely related species;to investigate the parasite fauna of nest-boxes and to establish their function as a possible reservoir of ectoparasites which might infect ducklings.

Before providing details of this study it is,however,necessary to discuss briefly certain aspects of the ecology of Australian waterfowl and to indicate features of potential ectoparasites with emphasize on the species which were encountered during this study.

Waterfowl in Australia.

The 7.682.300 square kilometer land mass of Australia extends from far into the tropics to the southern mid-temperate region and provides a wide range of climate and environment,but despite this it is the poorest continent of all with respect to the number of species of waterfowl it supports.

There are about 148 species of waterfowl in the world(e.g. Delacour,1954-1964) and of these only nineteen are native to Australia; there are also two occasional visitors and two introductions.Many Australian waterfowl are closely related to species that occur in other countries e.g. the Teal,Shovelers and Black Duck groups are more or less cosmopolitan but there are six endemic genera not closely related to any other so far as is known(Frith,1977).These are:

-Cape Barren Goose,Cereopsis

-Magpie Goose,Anseranas

-Freckled Duck,Stictonetta

-Pink-eared Duck,Malacorhynchus

-Wood Duck,Chenonetta

-Musk Duck,Biziura

In accordance with the classification of Delacour and Mayr(1945) the family Anatidae is subdivided into the following three subfamilies:

I Subfamily Anseranatinae,formed by the unique species the Magpie Goose,Anseranas semipalmata.

II Subfamily Anserinae

III Subfamily Anatinae

The classification of the Anatidae,down to the level of the tribe is summarized in Table 2 ,which shows the placement of all the Australian species.

In this report,data on ectoparasites were obtained from the following species:

-Freckled Duck,Stictonetta naevosa

-Mountain Duck,Tadorna tadornoides

-Black Duck,Anas superciliosa

-Grey Teal,Anas gibberifrons

-Chestnut Teal,Anas castanea

-Shoveler,Anas rhynchotis

-Pink-eared Duck,Malacorhynchus membranaceus

Before discussing the ectoparasite study,brief details of each species' natural history follows:

Freckled Duck(Stictonetta naevosa Gould)

The relationship of the Freckled Duck with other waterfowl is still obscure since it combines anatomical and behavioural features that are considered characteristic of either subfamily e.g. Anseranatinae,Anserinae and Anatinae.

The study of the birds'biology,behaviour and anatomy is continuing but at present there seems no reason to consider its many Anserine features all to be the result of convergence.The currently accepted view is that the bird is within the Anserini,but that it is not closely related to the Dendrocygni or other tribes.Stictonetta is therefore placed in a separate monogeneric tribe of the Anserinae,the Stictonettini (Frith,1977).

The breeding habitat of the Freckled Duck is considered to be heavily vegetated areas of fresh water and these are also favoured at other times.In the non-breeding season Freckled Duck are nomadic and move erratically throughout the breeding range and beyond.

Although the Freckled Duck is not as rare as is sometimes suggested it is among the less common of all Australian ducks and one of the rarer waterfowl of the world.Although widely distributed it is not numerous and its main populations are supported by a very small number of permanent swamps,mainly in inland New South Wales.

Mountain Duck(Tadorna tadornoides Jardine and Selby)

Mountain Duck are nearly always found in flocks that can be large and commonly number more than a thousand birds,except in the breeding season when non-breeding birds are found in small groups. The pair bond in Mountain Duck is very strong.Both adults select the nest-site,flying into the trees and examining the hollows. Usually,with birds that have bred before,the same nest hole that was used in the previous year is selected.

The preferred habitat of the Mountain Duck is the muddy shoreline of large brackish lakes or estuaries,but it is by no means restricted to this and large flocks form on deep clear freshwater lakes and in freshwater lagoons and billabongs.

The Mountain Duck is restricted to south-east and south-west Australia.In eastern Australia the main populations are in south-eastern South Australia and the western districts of Victoria,in Tasmania and on the Southern Tablelands of New South Wales.

Black Duck(Anas superciliosa Gmelin)

The Black Duck is found throughout Australia on all fresh, brackish and sometimes saline habitats.Despite this,however,they are most characteristic of relatively deep and permanent water with heavy vegetation.The Black Duck is certainly the most widely spread breeding species and probably the most numerous duck in Australia(Frith,1977). In the inland the immense nomadic flocks of Grey Teal(Anas gibberifrons) are very impressive but they fluctuate greatly in number and distribution whereas the Black Duck is reasonably common.

The breeding season is timed to occur when water areas are most extensive and the swamp plants have developed to provide abundant food. This results in breeding in northern Australia mainly at the end of the wet season,in autumn,and in southern Australia mainly in the spring.

Grey Teal(Anas gibberifrons Müller)

The Grey Teal is closely related to other Southern Hemisphere Teal;the group is collectively known as the Austral Teal and comprises the Grey Teal,Chestnut Teal(Anas castanea),Madagascar Teal(A.bernieri) and New Zealand Brown Teal(A.aucklandica).

The preferred habitat of the Grey Teal are the billabongs,lagoons and floodwaters of inland rivers.At all times most of these have a permanent breeding population of teal,and in times of flood the flood-waters are rapidly colonized by very large nomadic groups.

The initiation of the breeding season is controlled by rainfall and its effects,and the most important factor is apparently the increase in waterlevel in the billabongs(Frith,1959).

It has been found that flooding or water-level rise in the billabongs increases the food available for the ducklings.The insects which form their food also have a breeding season geared to changes in water-level,and a rise in the level of the billabong is rapidly followed by breeding and a great increase in numbers of water-boatmen,Corixidae, the main food of ducklings.

The Grey Teal is one of the most numerous ducks in Australia, only being rivalled by the Black Duck.

Chestnut Teal(Anas castanea Eyton)

The Chestnut Teal is usually grouped with two other species known collectively as the Austral Teal(see above).

Although they are very distinct species,the Chestnut Teal and the Grey Teal were originally confused at the beginning of this century and it was thought that only one species inhabited Australia.The assumption of Gould(1865) that there was more than one species was not established until breeding experiments were performed in 1882(Frith,1977)However,the matter was well resolved by the time of 1926 when the first Australian checklist was produced(Royal Australasian Ornithologists Union,1926).

Because of their close relationships Chestnut Teal and Grey Teal were of particular interest for a study of their ectoparasite fauna for the Mallophaga are assumed to be species specific(Clay,1957).

It has been observed at Serendip that,presumably hybrid,Grey Teal participate in the courtship behaviour of Chestnut Teal but the occurrence of hybrids is very rare(Norman,pers.comm.).

Whilst it is often considered that the Chestnut Teal is uncommon or rare,within its range and in the preferred habitat it may be a common duck.

Shoveler(Anas rhynchotis Latham)

The Shovelers are included in the large genus Anas and within this genus are included a group of rather similar birds known as the Blue-Winged Ducks.The Australian Shoveler is restricted to Australia and New Zealand.

The preferred habitat is formed by the more permanent,heavily vegetated swamps:the cumbungi swamps of the inland and the tee-tree swamps of coastal districts.

Shovelers were never very abundant compared to other ducks but there is evidence that their numbers have further declined since settlement(Frith,1977).In coastal districts,where its greatest populations were,the rich swamps have nearly all been drained and converted to pasture.Inland its nesting habitat,the grass- and lignum covered edges of swamps and lagoons,has been trodden and eaten by sheep and feral pigs and invaded by countless introduced foxes.It is a surprise after all that the predominantly ground-nesting Shoveler has survived it all.

Pink-eared Duck(Malacorhynchus membranaceus Latham)

The Pink-eared Duck has characters of the two tribes Anatini and Cairinini.Because its life habits as well as its form more closely resemble the Anatini it has been placed in this tribe(Frith,1977).

The Pink-eared Duck is an extreme nomad and it might be found anywhere in the continent at some time depending on habitat availability. Its breeding range covers most of inland Australia,wherever rainfall or flooding can produce extensive pools of shallow temporary water among nesting sites such as lignum,tall bluebush or dead timber.
Pink-eared Ducks have apparently no regular breeding season at all because its sexual cycle is initiated by,and geared to rising water levels (Frith,1977).

Acari (Mites and Ticks)

The Acari are the most heterogeneous subclass of the class Arachnida and can not be defined in terms of a small set of characters. In this subclass the body (Fig. 1) is always divisible into two regions, the gnathasoma (comprising the mouthparts) and the idiosoma. The latter can be divided by a transverse furrow located between legs II and III into an anterior propodosoma and a posterior hysterosoma. The region behind the legs (opisthosoma) is never clearly separated from the anterior part of the body.

The chelicerae and palps may be simple or modified. The genital and anal orifices vary in position although commonly the former is situated between coxae IV and the latter is subterminal. Respiration is cutaneous or effected by trachea, which in some orders open to the exterior by paired stigmata.

All the larvae of the Acari have only six legs in contrast to other Arachnida. After the larval instar up to three active, morphologically different nymphal stages with four pairs of legs occur (Sheals, 1973).

Systematic accounts of mites are given by Vitzhum (1934) and Baker and Wharton (1952) but more recently Atyeo and Gaud (1978) and Gaud (pers. comm.) have provided keys to the many new genera and families which have been created in the last decades.

In the higher classification the nature of the respiratory system and the position of the respiratory openings provide useful diagnostic features.

Seven orders can be recognized:

-Notostigmata(=Opilioacarida)

-Tetrastigmata(=Holothyroidea)

-Metastigmata

-Mesostigmata

-Cryptostigmata

-Astigmata

-Prostigmata

In the next section only examples of representatives of the orders parasitic on birds will be given.

Acari-Metastigmata (Ticks)

Ticks are the largest acarines.The dorso-ventrally flattened body is sac-like in outline and the respiratory openings are located behind coxae IV or laterally above coxae III-IV.Each stigma lies on a sclerotized plate and a peritreme may be present.A conspicuous component of the mouthparts is the long hypostome which is armed with recurved teeth.

Roberts(1970) recorded 59 species of ticks from Australia. These species may be divided into three groups:

1) Introduced species associated mainly with domesticated animals and birds
2) Indigenous species found mainly on native fauna,some of which also occur in the New Guinea region
3) Species associated with flying hosts such as bats and birds.

In the class Aves around 70 host-parasite records have been made but only one for the Anatidae, in which the Mallard (A.plathyrhynchos) was infested with ticks of the Argas persicus group. However, Murray (1969) mentions that a "duck" has been killed as a result of a tick bite.

Although no publications are available on ticks on waterfowl several new records of ticks on birds in Australia have been made, eg. Hoogstraal et al. (1975, 1976), Kaiser et al. (1974, 1975).

Apart from the identification and systematics of ticks, Hoogstraal (1961, 1966, 1967) emphasizes the importance of ticks as disease vectors.

Acari-Mesostigmata

This order of mites has stigmata which are located dorso-laterally in the region of coxae II - IV. Associated with the stigmata are long anteriorly-directed grooves called peritremes. This order contains over 50 families of which the family Dermanyssidae most frequently affects the avian hosts. Examples are:

Dermanyssus gallinae (De Geer) which is an obligatory blood-sucking parasite with a wide host-range among wild and domestic birds. The mites leave the birds after feeding and hide in dark crevices. Smith et al. (1948) have reported that D.gallinae is capable of transmitting the virus of St. Louis encephalitis amongst chickens. Sikes and Chamberlain (1954) estimated the blood ingested by D.gallinae. As a protonymph the blood-uptake to full engorgement was 0.023 mg, as a deutonymph 0.052 mg, and as an adult 0.204 mg which is 2.7 times the bodyweight. With an extremely high infestation anaemia and death of the host may be the result.

Ornithonyssus sylviarum(Canestrini and Fanzago) is also a blood-sucking ectoparasite on wild and domestic birds which spents the whole lifecycle on the host.In the USA the virusses of western equine encephalitis and St.Louis encephalitis have been isolated from specimens taken from wild birds' nests(Reeves et al.,1955). Androlaelaps casalis(Berlese)is a cosmopolitan species and occurs in the nests of birds and small mammals.Zemskaya and Pchelkina, (1968) reported that this species can be infected by the rickettsia of Q-fever(Coxiella burnetti).

Acari-Prostigmata

The Prostigmata is the most heterogeneous of all the orders of the Acari,and its components include aquatic species,phytophagous, mycetophagous,predatory and parasitic species,as wel as free living terrestrial species,which are parasitic in the larval stage.

The chelicerae may be pincerlike but they are often modified in various ways to become,for example,hooklike structures or piercing stylets.The trachea open through paired stigmata situated between the chelicerae or further back on the dorsal surface of the pro-podosoma(Sheals,1973).

The cheyletoid family Syringophilidae Lavoipierre includes a group of 24 species of avian parasites.Mites of this family live in the quill of the feathers and subcutaneously in the wing tissue of birds.In the order Anseriformes,Chenophila branta has been recorded on Branta canadensis(L.)(Kethley,1970).

Acari-Astigmata

Members of this order are weakly sclerotized mites.The palps are two-segmented and lie closely adpressed to the ventral components of the mouthparts(infracapitulum).With few exceptions the chelicerae are pincer-like,and the idiosoma is often divided by a groove,the sejugal furrow,into a propodosoma and hysterosoma.Stigmata and trachea are never present.The order includes mycetophagous forms and detritus feeders as well as parasites.

The families Acaridae and Pyroglyphidae are both recorded as infesting nests of birds.

The family Laminosioptidae has been extended with a new subfamily Fainocoptinae after four species of mites were found in the walls of feather quills in Australian birds(Lukoschus and Lombert,1979).

The Epidermoptidae are the skin mites of birds.In a review Fain(1965) gives keys to the different families and genera. For example Dermation(Neodermation)anatum is mentioned as a frequent parasite of ducks as well as Epidermoptes(Epidermoptes) bilobatus and Microlichus sp.(Lalitha and Alwar,1960).

The family Sarcoptidae consists of the skin parasites of warm-blooded animals.Some species cuase mange in mammals and others are responsible for "scaly-leg" and loss of plumage in birds. Interest in the Sarcoptiform feather mites(Acarina:Analgoidea) has been substantial in the last years.In particular Atyeo and Gaud have published several papers on the identification,systematics and new host-parasite relationships.(e.g. Gaud and Atyeo,1974,1977).

Of particular importance in the identification is the chaetotaxy.Understanding of the basic principles set out by Atyeo and Gaud(1966,see Appendix 1) is necessary for using the following key to the mites on Anatidae(kindly supplied by Atyeo and Gaud, pers.comm.)

Mites from Anatidae W. Atyeo and J. Gaud (pers. comm.)

1.	Three ventral setae on leg IV	2
	less than three ventral setae on leg IV	8
2.	Legs III and IV inserted ventrally. Setae p and q absent on all the legs (Family Freyanidae)	3
	Legs III and IV inserted laterally. Setae p and q present (Family Rectijanuidae)	Rectijanua Gaud 1961
3.	Presence of heteromorphic males that are asymmetrical Males with epiaudrium. From Nomonyx	Parafreyana Cerny 1969
	Absence of asymmetrical males, common form from Anatidae	Freyana Haller 1877
4.	Humeral setae ventral	5
	Humeral setae inserted laterally	6
5.	Forms rounded, femora I and II of equal size (2 species)	Freyanopsis Dubinin 19[illegible]
	Forms rectangular, femora II two times larger than femora I (monotypic)	Pelecymerus G & A 1975
6.	Genua I and II deformed by an apophyse which is strongly sclerotized, palps normal in male (monotypic)	Allofreyana G & A 1975
	Genua I and II without apophyses, 2nd segment of palps hypertrophied in male, (monotypic)	Dobyella G & A 1975
7.	Elongated females; oviporus as long longitudinal slit pregenital apodeme horse shoe shaped (Fam. Rectijanuidae)	Rectijanua G&A 1961
	Other combinations of characters	8
8.	Setae kT present on leg IV. Femur and genua clearly defined and mobile in respect to each other (Family Avenzoariidae)	9
	Setae kT absent on leg IV. Femur and genua more or less close together on all the legs	10
9.	Male heteromorphism expressed as enlarged gnathosoma, propodosoma and anterior legs	Bdellorhynchus Trouessart 1885
	Male heteromorphism expressed as enlarged chelicerae	Zygochelifer ng
10.	Hysterosomal shield of the female reaching at the back part of the posterior extremities of the opisthosome With the males, leg IV is always stronger than leg III (Alloptoidae)	11
11.	Legs short and thick, length at least four times the diameter. Opisthosomal lobes of the male absent or very short	12
	Legs clearly longer. Opisthosomal lobes of the male separated and long	13
12.	Subhumeral setae at the same level as the humeral setae or slightly anterior of these	Alloptellus
	Seta sH clearly posterior to setae H	Alloptoides Gaud 1961
13.	Seta vi present. Seta kT present on tibia III	Brephosceles Hull 1934
	Seta vi absent. Seta kT absent on tibia III	Heterobrephosceles

Phthiraptera (Lice)

The order Phthiraptera includes the Mallophaga or chewing lice and the Anoplura or sucking lice. The suborder Mallophaga is divided into two superfamilies, the Amblycera and Ischnocera.

The Amblycera can be divided into six families of which three families occur on birds:

-Menoponidae

-Laemobothriidae

-Ricinidae

Of the three families of the Ischnocera only one family, Philopteridae, occurs on birds (Clay, 1952).

Recently (Clay, 1970) the proposition has been made to drop the name Mallophaga and divide the Phthiraptera into four suborders: Amblycera, Ischnocera, Rhynchophthirina (elephant lice), Anoplura.

The life cycle of lice can be described as follows (after Turner, 1971, Martin, 1934). After three or four days the young nymphs hatch and undergo growth and development, including three instars about a week apart. At the end of the fourth week the adult lice emerge. The total cycle is about 30-36 days. The eggs are laid in rows, usually on the flight feathers and in areas relatively safe from the bill of the host.

Lice from the suborder Ischnocera are usually feather feeders only and feed in sharply defined areas. Lice belonging to the suborder Amblycera take blood and serum in addition to feathers.

Some species of the latter puncture feathers in the quill to take blood from the central pulp in the growing feather.

The present distribution of the Mallophaga in members of the class Aves suggests that they became parasitic on birds at an early stage in the evolution of that class and that they evolved with their hosts.In a goup of related hostspecies,each species may be parasitized by an allopatric species of each of a number of sympatric genera of Mallophaga common to the host group and in addition,sympatric species of one or more of these genera. In many cases therefore,a single host species may be parasitized by a number of genera and species of the Mallophaga(Clay,1957; Eichler,1958).

Interspecific transmission of bird lice is achieved mainly during host-mating,breeding of the young,rooting of gregarious species and by using common dusting baths.Occurrence of inter-specific transmission is quite rare due to the physical stucture of the feathers,chemical composition of blood and feathers,temperature differences and competition with normal lice populations already established(Turner,1971).

The mallophagan fauna of the Anseriformes(Screamers,Ducks, Geese and Swans) comprises a homogeeous and distinctive group. There are three amblyceran genera:Trinoton,Holomenopon,Ciconiphilis and three ischnoceran genera:Anatoecus,Anaticola and Acidoproctus which are characteristic as ectoparasites of the Anseriformes.

In the literature no key exists to the separate genera but the following one,provided by Chris Lyal(British Museum,pers.comm.) can be used:

1 Maxilliary palps present;antennae concealed in antennal fossae when at rest(Amblycera) 2

Maxilliary palps absent;antennae projecting from sides of head(Ischnocera) 3

2 Lobes covering antennal fossae projecting;all three thoracic segments clear;over 4 mm in lenght Trinoton

Lobes coverig fossae not projecting;mesothorax reduced metathorax similar to abdominal segments dorsally: under 3 mm in lenght Holomenopon

3 Long,slender wing lice Anaticola

Short,stout head and neck lice 4

4 Abdominal pleurites with ventral wedge shaped projection, male genitalia with parameres fused apically Anatoecus

Abdominal pleurites without such projection,male genitalia with parameres free apically Saemundssonia

Saemundssonia is only known from Malacorynchus membranaceus (Pinkeared Duck)

For more detailed identification Tables I refer to the publications by Clay(1960,Menoponidae;1970,Amblycera).

The Australian louse fauna may be divided into four categories:

1) Endemic species from endemic host species
2) Widespread species occurring on hosts that occur also in other parts of the world
3) Species which are apparently not very host specific and occur on native hosts,but which are not specifically distinguishable from lice occurring on related hosts in other parts of the world
4) Introduced species parasitizing domestic and feral introduced birds and mammals.

The Phthiraptera are among the least known insects of Australia. Calaby(1973) mentions that less than 180 native species have been recorded,however,without giving any details.

The families of importance for the class Aves,Menoponidae and Philopteridae have representatives recorded in Australia.In the Menoponidae approximately 35 native species in about 20 genera have been recorded from Australian birds(Calaby,1973).

The Philopteridae have about 90 native species in about 45 genera recorded,eg.Anaticola crassicornis and Anatoecus dentatus from ducks(Roberts,1952).

As a result of the study of Lavery(1967) of waterfowl in North Queensland,Clay(1961,1963) described three new species of Trinoton,all parasitic on Dendrocygna sp..

Among more recently described Philopteridae,a new species of Austrogonoides from Western Australia is apparently an established parasite of a diving duck,Biziura lobata(Clay,1971).

Apart from the publications of Lapage(1961),with some records of Phthiraptera on Australian waterfowl and the more recent work of Lavery(1971) and Clay(1971),no other records are available for Australian waterfowl.The collection of Mallophaga in the National Museum,Melbourne(Victoria) has no systematic index and can not be used.In contrast several publications are available on Mallophaga in America(Broderson et al.,1977;Malcolmson,1960) and the Netherlands(Van den Broek and Jansen,1964).The lack of publications may be due to difficulties in obtaining the hosts and final identification of the parasites.Besides,the role of lice as vectors of diseaes in wild birds has not yet been revealed,which makes research-work primarily of interest to the systematists only.

However,in a survey of wild birds in Britain(Keymer et al., 1962) from the 2044 birds examined only nine carried a parasitic burden that could be considered pathogenic.As soon as the birds are sick or weakened the infestation by lice will increase(Turner, 1971).

Siphonaptera (Fleas)

All the publications on Siphonaptera in Australia from 1843 to 1972 have been summarized by Dunnet and Mardon (1974). Eighty-three species and subspecies of fleas from 31 genera and nine families are recorded in Australia. The majority of species are endemic (native to or naturally occurring in the area), eight are indigenous (native and confined to the area) but occur elsewhere while ten are introduced with man and its commensals.

Although twenty-five records of fleas on representatives of the class Aves are made, no record of Siphonapters on the Anatidae is available. Nor is it considered likely to find any fleas on the Anatidae (F.G.A.M. Smit, pers.comm.).

However, in the study by Hicks (1959, 1962, 1971) on the occurrence of insects in birds' nests *Ceratopyllus* sp. were recorded in all the nests of the Anatidae examined.

The Hippoboscidae

Despite the fact that 405 recorded cases of phoresy between lice and hippoboscidae have occurred on 11 of the 27 non-passerine bird orders and 284 cases occurring on 22 passerine no records are available for the Anseriformes(Keirans,1975).

As an explanation of this fact part of the publication by Bequaert(1953) can be cited:

"The large group of the waterfowl,with the two families Anatidae and Anhimidae,comprises aquatic birds with dense,but rather short and oily plumage,which nest in very damp situations,the young usually leaving the nest immediately after hatching.These features no doubt explain why they do not serve as a breeding host to any known hippoboscid.Any records may safely be disregarded as either strays or contaminations without further significance."

Materials and Methods

1) Collecting ectoparasites from wings and feathers of ducks shot at Lake Buloke and Sale (Victoria).

2) Trapping of Chestnut Teal (Anas castanea) and Grey Teal (A. gibberifrons) for ectoparasite search at Serendip (Victoria).

3) Examination of nest-box material for the presence of ectoparasites in Serendip (victoria).

1) Collecting ectoparasites from wings and feathers of ducks shot at Lake Buloke and Sale(Victoria).

The Department of Fisheries and Wildlife has chosen Lake Buloke,apart from other locations in Victoria,to carry out yearly surveys at the opening of the duck-shooting season for information on the numbers of duck shot,species,sex-ratio,moult condition, reproductive state and success of the hunters in general.Lake Buloke is an extensive wate area of approximately 56000 ha surrounded by Eucalypts situated in the north-west of Victoria.

The number of duck shot and the species composition show a high variability over the years(Table 3).The majority of duck shot is formed by Grey Teal(Anas gibberifrons) and Black Duck (Anas superciliosa).

The evening before the opening of the season(1st of march,1980) the hunters were informed about the activities planned.As the hunters came in the next morning with their bags the required information was obtained.The birds were identified,sexed,aged and the wings were separated from the body:one for establishing the moult condition and one for the ectoparasite search.The wing was placed in a plastic bag and labelled identically to breast-feathers taken from the same bird which were retained in a separate bag.

In this way a representative sample of the ducks shot could be made.(Table 4)

Four wings and breatfeathers of Chestnut Teal(Anas castanea) were also collected at Sale(Victoria) on the same day.

Several methods for collecting ectoparasites are described in the literature eg. Harshbarger and Raffensperger(1959),Lavery (1967),Watson and Amerson(1967),Murray(1969).

Two methods were used in obtaining the ectoparasites:

1) Examination of the feathers with a low-power dissecting microscope(5-20X).The Mallophaga and Acarina were picked up with a fine brush and stored in glass vials(0.5X4 cm) with 70% ethanol, with a label inside stating the location,date and duck species. This method,although time consuming,produced good results for wings.For the processing of the feathers the following method was used.

2) All the feathers of a particular duckspecies were pooled and used for the complete dissolving method(Watson and Amerson,1967).

The dissolving solution consists of 500ml distilled water and 15 g dibasic anhydrous sodium phosphate($NaHPO_4$).The feathers were placed in a container with the solution in a 38°C oven for at least 12 hours. After this period 15 g of potassium hydroxide(KOH) was added and the liquid boiled until the solid material was dissolved.After cooling the mixture was poured through a bronze sieve(0.2 mm) and the screen was examined for ectoparasites which were not affected by the solution.

After processing all the material the Acarina were separated from the Mallophaga and the vials were forwarded to authorities for identification of the specimens:

Dr Jean Gaud,Laboratoire de Parasitologie,Faculté de Médecine, Nice-cedex,France (Acarina)

Mr Chris Lyal,British Museum(Nat.History),London (Mallophaga).

2) Trapping of Chestnut Teal (Anas castanea) and Grey Teal (A. gibberifrons) for ectoparasite search at Serendip (Victoria).

Study area

Serendip Wildlife Research Station, near Geelong (Victoria) (Fig. 2) is about 2.6 square kilometers in size of which 1.2 are are grazed or cropped. The rest is grassland, animal pens and a system of shallow lakes (maximum surface area c.34 ha, maximum depth 3m) consisting of pondages connected by spill-ways and filled by two intermittent streams. Surplus bore-water, used in experimental pens, maintains one pond at a more constant level than the others which in years of low rainfall may dry out. Rainfall (505 mm, 10 years' average) is generally distributed throughout the year and mean maximum temperatures occur in January (Norman et al., 1979).

The breeding activities of the ducks at Serendip are closely observed by means of fortnightly checks on the number of eggs and by behaviour observations. As a result of these records it was possible to plan three trapping trips, eg. before the breeding season (26th of august, 1980), during breeding activities (7th of oktober) and after the breeding season (3rd of december).

Three traps were made of chicken-mesh, approximately 2X2X1.5 m with two openings which could be closed by means of cones. Three days before the actual trapping the ducks were fed with oats in the traps of which the cones were removed. Early in the morning of the trapping day the cones were placed in the trap to prevent the ducks from escaping. At dawn the trapped ducks and other waterfowl were removed from the traps and taken to a banding shed. All the trapped waterfowl were banded and released and the Grey- and Chestnut Teal were retained for later examination.

Since ducks were not to be killed,collection techniques for the ectoparasites had to cater with live birds.

Watson and Amerson(1967) describe a method in which birds are dusted with a dessicant such as pure silicagel without a propellant(Trade name "Dri-die") which,when dusted on a host in a plastic bag,causes Arthropods to lose water and detach in 5-10 minutes.

Floyd and Tower(1956) used the insecticide pyrethrum to dust into the feathers.The pyrethrum irritates the Arthropods causing them to migrate to the surface of the feathers;finally they die and are easily removed by vigorously disturbing the feather tracts.Because of the ready availability of pyrethrum and the apparent success of the method,it was used in this experiment.

The duck was thoroughly dusted with pyrethrum and put in a strong polyethylene bag with its head outside.The duck was kept for about ten minutes inside the bag and the feathers were disturbed during and after this time.In the mean time the head of the duck was examined for the presence of any parasites.After the whole procedure the duck was released without any obvious harmful consequences following the treatment.A label was put inside the plastic bag with the banding number,species,sex and age of the duck and tightly closed.

During the second trapping session a primary was pulled out of the wing for examination for the presence of mites which live in the quill(eg.Lukoschus and Lombert,1979).

An alternative method was also attempted during the third session.Carbon dioxide,from frozen blocks,was cut into pieces, put in a tin,the temperature was raised by adding a little water and the resulting gas was poured into the plastic bag with the duck after which the same procedure as with pyrethrum was followed. However,after three ducks were treated without any positive results this method was discontinued and only pyrethrum was used.

This technique did not enable the location of ectoparasites to be determined.In an attempt to achieve this,five ducks were treated as follows:a plastic bag was placed around each wing as well as around the whole body and the wings.

The plastic bags were examined in a draught-free room.The obvious Mallophaga and Acarina were picked up with a fine brush and stored in 70% ethanol.The plastic bag was then emptied on a white surface.By means of a large magnifier the surface was examined for any remaining ectoparasites.Before a new bag was examined the surface was cleaned completely.

After collecting the ectoparasites the vials were sent to Dr Jean Gaud (Acarina) and Mr Chris Lyal (Mallophaga).

3) Examination of nest-box material for the presence of ectoparasites in Serendip(Victoria).

At Serendip 66 nestboxes are placed around the lake's periphery and these are f quently used by Chestnut Teal.

Before the start of the breeding season(9th of july,1980) ten nestboxes were removed from the posts and replaced by clean new boxes.The ten boxes were thoroughly cleaned and the contents were put in plastic bags for examination.

The content of each box was subdivided and processed in the following ways:

1) Nest-box material was put into containers near the central heating system(temperature range 10-20°C).Since many of the mites were in a larval stage,it was anticipated that this would stimulate development into mature stages.

2) Nest-box material was kept in the polyethylene bags and regular collections of mites moving about were made which were stored in vials with 70% ethanol.

3) The nest-box material was put in a Buechner funnel(diameter 10cm) connected to a flask with water and with two 60W lamps positioned on top of it(eg.adjusted Tullgren funnel).The parasites,in particular fleas,try to eascape from the light and heat source and drop into the water from which they can be easily collected(Smit,1957).

4) Five sieves of different mesh diameter(2,1,0.5,0.25,0.10 mm) were put on top of each other in a shaking machine.After ten minutes each sieve was emptied onto a white surface and examined for ectoparasites by means of a magnifier(15X).

5) The nest-box material was put in 70% ethylalcohol in a separating funnel,so that the funnel was slighly over half full.Approximately 5 ml of kerosene were added and the contents of the funnel were thoroughly agitated by shaking for a few seconds after which the kerosene rapidly separated out at the top of the funnel,and the alcohol dropped below.The kerosene contains the Arthropods,the integuments of which are more rapidly wetted by kerosene while the alcohol contains the soil and plant material.The kerosene layer was removed and washed several times with alcohol.The Arthropods were stored in vials with 70% ethanol.

After processing with the different methods all the nest-box material was put together again for each box separately and used in method 4 and 5,which seemed to be most rewarding.

These two methods were also used in combination after collecting the nest-box material after the breeding season(22nd of january,1981).

The vials with the collected Arthropods were sent to:
Dr Robert Domrow,Queensland Institute of Medical Research,Brisbane for identification.

Results

1) Survey of ectoparasites of Victorian waterfowl.

2) Ectoparasites recorded from wild,trapped Chestnut Teal and Grey Teal at Serendip (Victoria).

3) Examination of nest-box material for the presence of ectoparasites at Serendip (Victoria).

1) Survey of ectoparasites of Victorian waterfowl.

The examination of the wings of birds collected at Lake Buloke and Sale with a low-power dissecting microscope (5-20X) resulted in a high yield of ectoparasites.Whilst some of the Mallophaga were in coverts of the tertiaries,the majority of them occurred in coverts overlying the major flight-feathers (primaries and secondaries). At the same time large amounts of mallophagan eggs were found in parallel rows along the shafts of the feathers.

Mites,when present occurred only close to the quills of the feathers.No mites could be found in the quills of the primaries and nasal mites were not collected in this study.

Details of incidence of both species of Mallophaga and Acarina are summarized in Table 5 .

2) Ectoparasites recorded from wild,trapped Chestnut Teal and Grey Teal at Serendip (Victoria).

Most of the waterfowl caught at Serendip during three trapping sessions (26th of august,7th of oktober,3rd of december) were Chestnut Teal and Grey Teal (Table 6);some Coots and a few Black Ducks.Of the total of 65 Chestnut and Grey Teal trapped only one female and male Chestnut Teal were trapped twice during the three sessions.

By comparison with the results of Lake Buloke two additional Mallophaga species were found on the trapped Chestnut Teal:*Anatoecus* and *Anaticola crassicornis*.*Anaticola crassicornis* and *Rallicola fullicae* were recorded on Grey Teal.

Two further species of Acarina were found on the wild-caught Chestnut Teal:*Alloptoides* sp. and *Ingrassia* sp.The latter species was also found on Grey Teal.

A list of all parasites recorded for Chestnut Teal and Grey Teal in Lake Buloke and Serendip is summarized in Table 7.

3) Examination of nest-box material for the presence of ectoparasites at Serendip (Victoria).

The nest-box material collected the first time(9th of july) consisted merely of plant material.The intrusion of plant material in the nest-boxes may be the result of starlings and sparrows which visit and use the nest-boxes as well.The duck only covers the nest with downy breastfeathers which she plucks out of her body.The absence of downy material in the series of boxes examined but presence of plant material may explain the presence of the following two mite species which were found:

-Glycyphagus domesticus (De Geer,1778)

-Lepidoglyphus destructor (Schrank,1781)

Neither Glycyphagus nor Lepidoglyphus are specific parasites of the Anatidae or known vectors of diseases which could do any harm to the ducks.

As the material from the nest-boxes which were cleaned before breeding activities started was collected (22nd of january,1981), it harboured the same mite species.However,the infestation on this occasion was reduced by comparison with the first sampling when the mites were very abundant.

Using the separating method with the second samples Crustacean larvae (Amphipoda),family Tallitridae (Sand hoppers) were present. (Identification by Dr.Garry Poore,Nat.Mus.Melbourne).These could have been carried into the nest-boxes after feeding in the muddy shoreline as they stuck to the feathers or feet.They are not known as vectors of any disease(Poore,pers.comm.).

The collection method described by Smit (1957) to collect fleas from nesting material was unsuccessfull,presumably because of the absence of any fleas in the material.Indeed,no fleas were encountered during the whole study.Indeed,nest-boxes must be viewed as an artificial nesting habitat for they may have different humidity and temperature (Norman and Riggert,1977) than a normal nest.These natural sites are more likely to be infested with ectoparasites.All the nests of Anatidae which were examined in the study by Hicks (1959,1962,1971) harboured *Ceratophyllus* species (fleas).

Due to extremely low rainfall during the last breeding season the results of breeding were nil and no ducklings hatched (Appendix 3). Therefore it was impossible to trap ducklings for ectoparasite examination and no conclusion can be given on the extent of ectoparasite infestation or transmission mechanisms between adults and young.

Discussion

The general survey provided an opportunity to collect wings and body feathers from series of waterfowl shot at the opening day of the duck-shooting season in Victoria.The results obtained by using a low-power dissecting microscope to examine the wings showed that it is possible to collect a representative sample of ectoparasites.

The most recent report on ectoparasites on waterfowl in Australia (Lavery,1971) gives records of host-parasite relationships for the Anatidae but in respect to the Acarina only *Freyana largifolia* was recorded for the Grey Teal(*Anas gibberifrons*) and Shoveler (*Anas rhynchotis*) and this record was originally given by Dubinin (1951). Comparing the results of this study with earlier reports indicates an extension of host-parasite records for Mallophaga as well as for Acarina (Table 1).

The twenty new host-parasite records for Mallophaga and Acarina look very promising but it should be emphasized that the ducks shot were not necessarily segragated by the hunters which created a possibility of contamination of ducks with ectoparasites from different duck species,so that they must remain tentative.

To eliminate this source of contamination it would be worthwhile to get experienced hunters,who can identify the ducks,to put ducks of a particular species in separate bags.Another possibility of course is to shoot the ducks individually and then process them separately.This would also make it possible to examine the whole body of the duck for the presence of ectoparasites,rather than just wings and body feathers as in this study.

However,by trapping wild Chestnut and Grey Teal the contamination problem was reduced.Usually,the trapped ducks remain quiet in the trap but Coots (Fullica atra) are extremely lively.This could explain the presence of Rallicola fulica (Denny) on Grey Teal for the normal host of this parasite is a Coot (Chris Lyal,pers,comm.).

The host-species list for these two duck species was further extended with three Mallophaga species and two Acarina species from birds trapped at Serendip.These records also show that it is worthwhile to examine the whole duck.In instances when the hosts are not supposed to be killed (as at Serendip) the insecticide powder pyrethrum can be used as a relatively good method for collecting ectoparasites. However,this method seems to be more suitable for collecting Mallophaga than Acarina and the latter can be easily confused with a pyrethrum particle because of their size.

The use of carbon-dioxide gas produced from frozen blocks was of little benefit.Though frozen carbon-dioxide blocks are difficult to handle,the use of carbon-dioxide gas from a cylinder may overcome that problem,it remains doubtful whether it would be successfull in killing the ectoparasites.

In comparison with other representatives from the Anas group, e.g. those of North America and Asia,the Australian ducks harbour the same genera and in some cases the same species of Mallophaga. (Table 8).Mallophaga are supposed to be host-specific (Clay,1957) so it is not surprising perhaps to find the same Mallophaga on representatives of the Anas group around the world.

The history of the arrival of Anatidae,and with them probably ectoparasites,in Australia remains still obscure.Because many of the more advanced subgroups within the Anatidae had differentiated by the end of the Paleogene,an initial dispersal of primitive anseriformes by a southern route could account for their occurrence

in Australia today,but also they could be relicts in Australia after arriving via Indomalaysia or over the sea.Most ducks are quite capable of long flight,so there is easy access really through the Indomalaysian route.The swans (Cygnini),shelducks (Tadornini), pochards (Aythini), teals and their relations (Anatini) probably moved south through Indomalaysia or crossed the sea into Australia rather late in the Cainozoic,as suggested by their low endemism (only Malacorhynchus and Chenonetta) and diversity in Australia as well as the high coincidence of species in the Old World and Australia (Rich,1975).The Black Duck (Anas superciliosa) is closely related to the Indo-Asia spotbill group A.poecilorhynca.Indeed, Johnsgard (1978) recently combined the Australian Black Duck with all other "grey" ducks.

Irrespective of the arrival time of Australian waterfowl it is known that movement of some species include dispersal into New Guinea and beyond e.g. Grey Teal (Frith,1977).

The Grey Teal is most nomadic of all Australian waterfowl and it could be possible that this duck functions as a source for a constant influx of ectoparasites from the Asian region into Australia. If Grey Teal is proposed as a passive vector then since it is the most nomadic and is found on a wide range of habitats then it overlaps with almost all other Australian waterfowl.

In this aspect the nesting site as a place for transmission should be emphasized.Nestboxes or nesting sites can be visited by more than one female e.g. apart from the laying female other females may visit the boxes or nesting site as they are looking for a nesting site or even lay eggs in an already occupied site ("dump-nesting").

Multiple use of tree-holes has been recorded for the same duck species or different duck species in subsequent breeding seasons(Norman, pers.comm.) which increases the opportunities for inter-and intra specific ectoparasite transmission between Grey Teal and Black Duck, the endemic Pinkeared Duck and the Chestnut Teal for they all use tree-holes as a nesting site.

Despite the extensive list of parasites for Chestnut Teal and Grey Teal it is impossible to state whether or not they harbour the same ectoparasites until the ectoparasites are identified beyond genus.

It will certainly be worthwhile to continue working in this field by means of collecting ectoparasites from ducks,alive or shot individually,and expand the knowledge of the ectoparasite fauna of Australian waterfowl for clarification of their origin, relationships and possible health hazards caused by the ectoparasites.

Table 1 : Ectoparasite records for Australian waterfowl (Lavery, 1971; Gaud, 1974; Van Mourik, 1981).

	Anseranas semipalmata Magpie Goose	Dendrocygna arcuata Water Whistle Duck	Dendrocygna eytoni Grass Whistle Duck	Stictonetta naevosa Freckled Duck	Anas superciliosa Black Duck	Anas gibberifrons Grey Teal	Anas rhynchotis Shoveler	Anas castanea Chestnut Teal	Malacorhynchus membranaceus Pink-eared Duck	Tadorna tadornoides Mountain Duck	Aythya australis Hardhead	Chenonetta jubata Wood Duck	Nettapus coromandelianus White Pigmy Goose
Anatoecus sp.						a		b				a	
Anatoecus icterodes												a	a
Anaticola sp.					b	a b	b	b	b	b			
Anaticola nyrocae											a		
Anaticola crassicornis					a	a b	b	b				a	
Trinoton sp.		a	a	b	a b	a b	b	b	b	b	a	a	a
Trinoton querquedulae				b	a	a b		b	b	b		a	a
Trinoton laveryi		a											
Trinoton sculeatum		a											
Trinoton fluviatile			a										
Holomenopon sp.			a			a	b		b	b		a	
Holomenopon goliath	a												
Acidoproctus sp.		a	a	b									
Acidoproctus emersoni		a											
Acidoproctus hilli	a												
Degeeriella			a										
Rallicola fulica						a							
Freyana sp.						a		b					
Freyana largifolia						a b	a	b					
Freyana microchaeta									a b				
Freyana australis stictonetta				a									
Freyana australis australis													
Freyana dendrocygni			a										
Allofryana oxygonata	c												
Dobyella longipalpa	c												
Pelecymerus tetragonus	c												
Fryanopsis periprochus	c												
Freyanopsis decidulatatusetae	a												
Alloptoides								a					
Ingrassia						a							
Bdellorhynchus								a					
Bdellorhynchus polymorphus					a	a		a					

a=Lavery(1971) and Lapage (1961)

b=this study;Van Mourik (1981)

c=Gaud and Atyeo (1974)

Table 2 : Classification of Australian waterfowl (Frith,1977).

Subfamily	Tribe	Species	
Anseranatinae	Anseranatini (Magpie Goose)	Anseranas semipalmata	Magpie Goose
Anserinae	Dendrocygnini (Tree-ducks)	Dendrocygna arcuata	Water Whistle-duck
		Dendrocygna eytoni	Grass Whistle-duck
	Anserini (Geese)	No Australian species	
	Cygnini (Swans)	Cygnus olor	Mute Swan
		Cygnus atratus	Black Swan
	Stictonettini (Freckled Duck)	Stictonetta naevosa	Freckled Duck
	Cereopsini (Cape Barren Goose)	Cereopsis novaehollandiae	Cape Barren Goose
Anatinae	Tadornini (Sheldgeese and Ducks)	Tadorna tadornoides	Mountain Duck
		Tadorna radjah	Burdekin Duck
		Anas platyrhynchos	Mallard
	Anatini (Dabbling Ducks)	Anas superciliosa	Black Duck
		Anas gibberifrons	Grey Teal
		Anas castanea	Chestnut Teal
		Anas querquedula	Garganey
		Anas clypeata	Northern Shoveler
		Anas rhynchotis	Shoveler
		Malacorhynchus membranaceus	Pink-eared Duck
	Somateriini (Eider Ducks)	No Australian species	
	Aythyini (Pochards)	Aythya australis	Hardhead
	Cairinini (Perching Ducks)	Chenonetta jubata	Wood Duck
		Nettapus pulchellus	Green Pigmy Goose
		Nettapus coromandelianus	White Pigmy Goose
	Mergini (Scoters,Goldeneyes,and Mergansers)	No Australian species	
	Oxyurini (Stiff-tailed Ducks)	Biziura lobata	Musk Duck
		Oxyura australis	Blue-billed Duck

Table 3: Species composition of ducks examined on the opening day of the shooting season at Lake Buloke (Victoria).

	1974	1975	1976	1977	1978	1979	1980
Total	382	1250	593	2974	1375	767	2365
Grey Teal	267	679	341	2199	923	310	1324
Black Duck	41	154	106	324	77	25	116
Wood Duck	1	88	61	24	4	2	14
Hardhead	10	23	6	211	66	6	10
Mountain Duck	17	11	34	12	190	114	79
Pink-eared Duck	31	187	19	110	81	213	567
Shoveler	10	50	10	48	29	91	172
Chestnut Teal	5	11	10	---	3	4	4
Freckled Duck	---	46	---	3	4	1	79
Others*	---	1	6	42	1	1	---

*Others include: Grass Whistle-duck
Blue-billed Duck
Musk Duck

Table 4: Number of wings examined from ducks shot at Lake Buloke and distribution over the duck species.

	Male		Female		
	young	adult	young	adult	?
Pink-eared Duck *Malacorhynchus membranaceus*	6	13	4	1	1
Grey Teal *Anas gibberifrons*	–	11	7	7	
Shoveler *Anas rhynchotis*	2	9	5	1	1
Mountain Duck *Tadorna tadornoides*	1	4	3	–	2
Black Duck *Anas superciliosa*	1	5	1	1	
Freckled Duck *Stictonetta naevosa*	–	2	1	–	
Chestnut Teal *Anas castanea*	–	–	–	4*	
Total	10	44	21	14	4

* from Sale (Victoria)

Table 5 : Host-parasite records for Victorian waterfowl.
(* new host-parasite record)

Malacorhynchus membranaceus (Pinkeared Duck)

Arthropoda

Mallophaga

* Trinoton sp.

* Trinoton querquedulae L.

* Holomenopon sp.

* Anaticola sp.

Acarina

Freyana microchaeta

Anas rhynchotis (Shoveler)

Arthropoda

Mallophaga

* Trinoton sp.

* Holomenopon sp.

* Anaticola sp.

* Anaticola crassicornis (Scopoli)

Anas superciliosa (Black Duck)

Arthropoda

Mallophaga

Trinoton sp.

Anaticola sp.

Acarina

* Bdellorhynchus polymorphus

Anas gibberifrons (Grey Teal)

Arthropoda

Mallophaga

Trinoton sp.

Trinoton querquedulae L.

Acarina

Freyana largifolia

* Bdellorhynchus polymorphus

Anas castanea (Chestnut teal)

Arthropoda

Mallophaga

* Trinoton querquedulae L.

* Anaticola sp.

Acarina

* Freyana largifolia

Stictonetta naevosa (Freckled Duck)

Arthropoda

Mallophaga

* Trinoton sp.

* Trinoton querquedulae L.

* Acidoproctus sp.

Tadorna tadornoides (Mountain duck)

Arthropoda

Mallophaga

* Trinoton sp.

* Holomenopon sp.

* Trinoton querquedulae L.

* Anaticola sp.

Table 6: Numbers of Chestnut Teal and Grey Teal trapped and examined for ectoparasites at Serendip(1980).

	26th of August	7th of Oktober	3rd of December
Chestnut Teal			
female	11	7	10
male	4	8	14
Grey Teal			
female	3	3	1
male	3	1	0
Total	21	19	25

Table 7 :Ectoparasite records for Chestnut Teal and Grey Teal

(* new host parasite record)

Anas castanea (Chestnut Teal)

Arthropoda

Mallophaga

* Trinoton querquedulae L.

* Anaticola sp.

* Anaticola crassicornis (Scop.)

* Anatoecus sp.

Acarina

* Freyana sp.

* Freyana largifolia

* Alloptoides sp.

* Bdellorhynchus sp.

* Ingrassia sp.

Anas gibberifrons (Grey Teal)

Arthropoda

Mallophaga

Trinoton sp.

Trinoton querquedulae L.

Anaticola sp.

Anaticola crassicornis (Scop.)

* Rallicola fulicae (Denny)

Acarina

Freyana sp.

Freyana largifolia

* Bdellorhynchus polymorphus

* Ingrassia sp.

Table 8 : Ectoparasite records for Anas representatives in Noth America,Asia and The Netherlands.

	Anatoecus sp.	Anatoecus ferrugneus	Anatoecus dentatus	Anatoecus icterodes	Anatoecus cygni	Anaticola hopkinsi	Anaticola sordidus	Anaticola depurcatus	Anaticola crassicornis	Anaticola coloratus	Anaticola anseris	Holomenopon steigerum	Holomenopon leucoxanthum	Holomenopon clypeilargum	Holomenopon setigerum	Holomenopon loomisii	Trinoton squalidum	Trinoton luridum	Trinoton lituratum	Trinoton querquedulae
Anas rubripes Black Duck			a c	c					a										a	a
Anas strepera Gadwall			a					a	d											a c d
Anas acuta Pintail									d					a				a		d
Anas crecca Common Teal							a		c d				a							c d
Anas carolinensis Green-winged Teal			a																	
Anas discors Blue-winged Teal	c		a						c											
Anas clypeata Shoveler		a	b	b		a			b d			a	b	b			a			d
Anas penelope European Widgeon									d											d
Anas querquedulae Garganey Teal									d											d
Anas plathyrhynchos Mallard			c						e											
Aythya collaris Ring-necked Duck			c	c					c											c
Aythya americana Redhead	c																			

a=Malcolmson (1960)

b=Broderson et al. (1977)

c=Threlfall and Bourgeois (1979)

d=McClure and Ratanaworabhan (1973)

e=Van den Broek and Jansen (1964)

Fig. 1: Division of the body of an acarid mite (Sheals,1973).

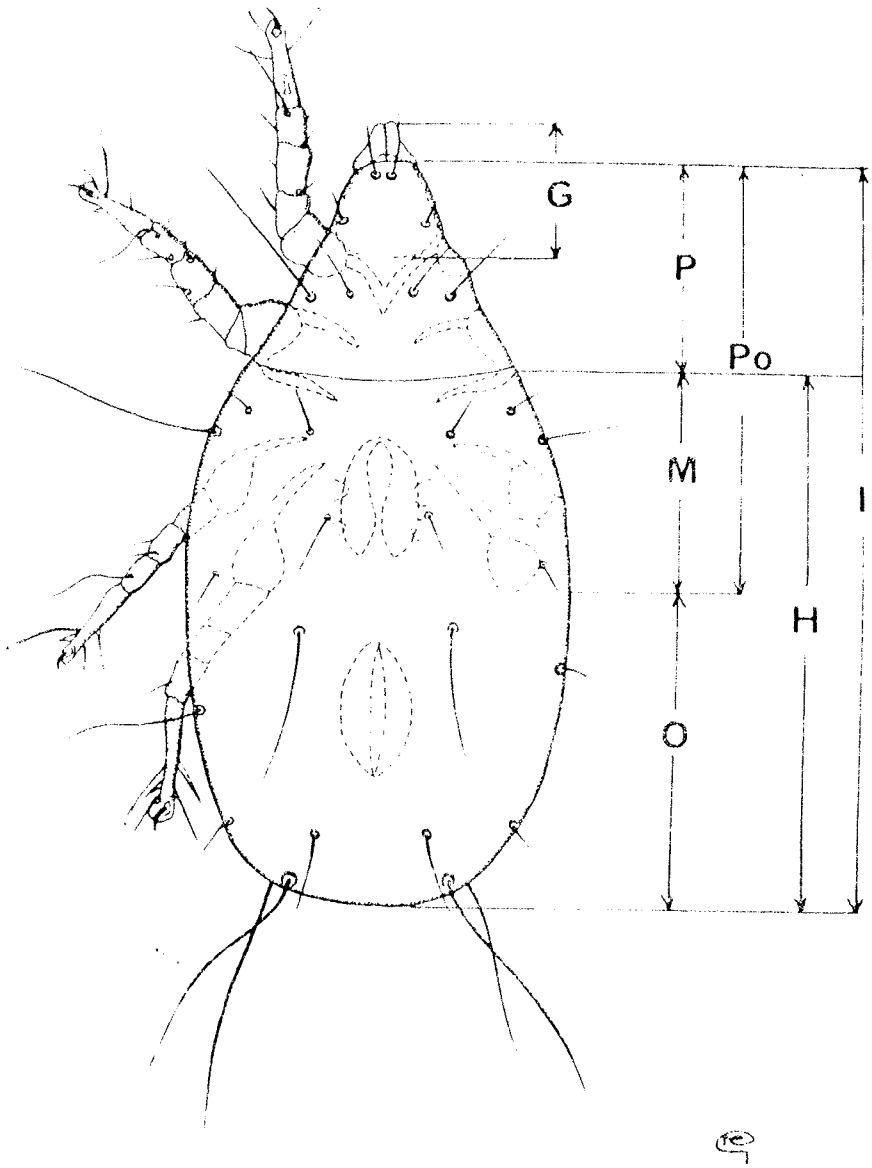

Fig. 192 Divisions of the body of an acarid mite (G, gnathosoma; H, hysterosoma; I, idiosoma; M, metapodosoma; O, opisthosoma; P, propodosoma; Po, podosoma—much enlarged)

Fig.2 : Map of Serendip (Norman et al., 1979).

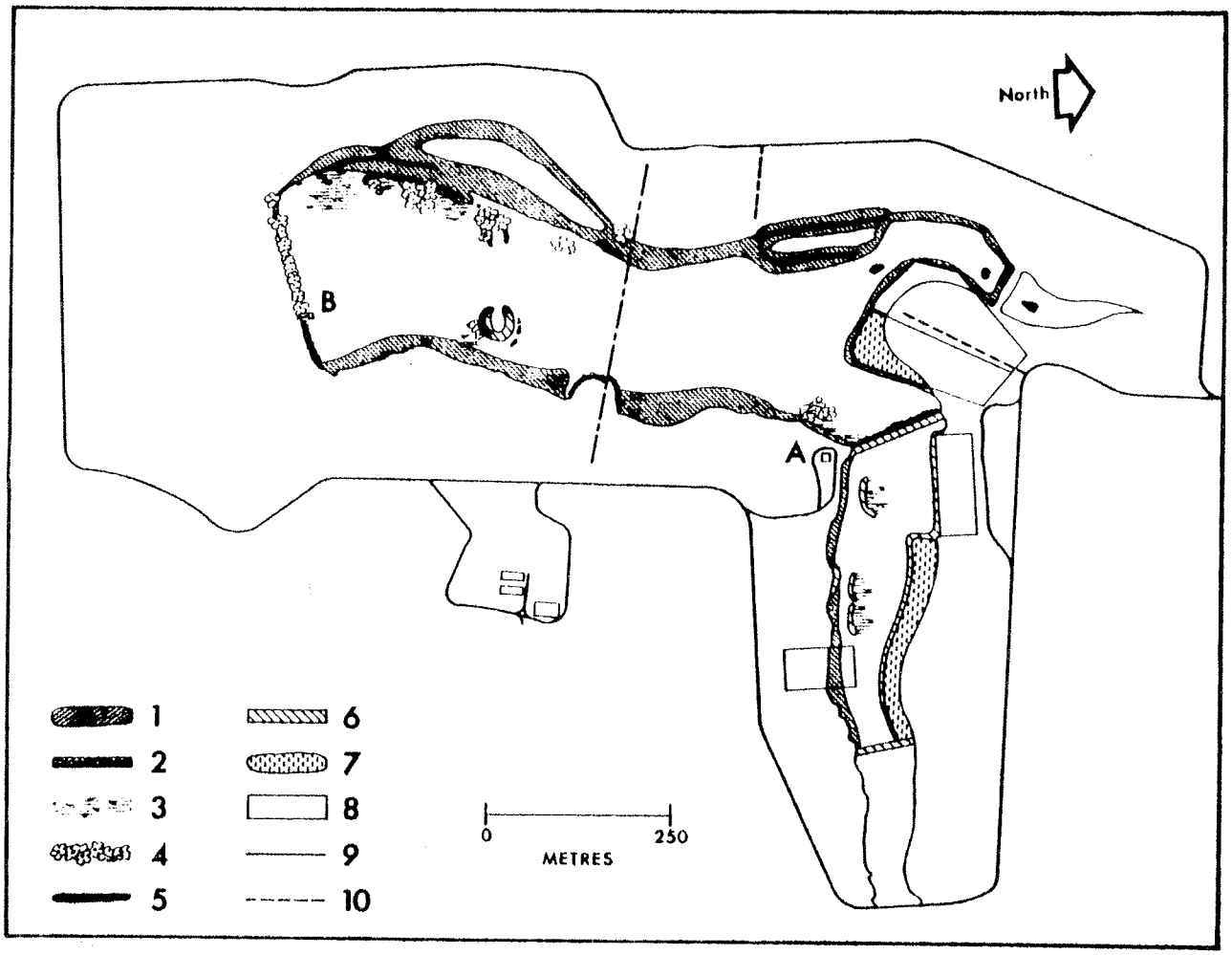

Figure 1. Map of ponds at Serendip, showing distribution of habitats (areas exaggerated for clarity). 1 = flooded grass and rush; 2 = rocky shoreline; 3 = dead trees and logs; 4 = willows; 5 = short grassland; 6 = tall grassland; 7 = milfoil ponds; 8 = pens and buildings; 9 = major tracks; 10 = minor tracks.

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Appendix 1.

VOL. 39, NO. 2, APRIL, 1966 337

THE CHAETOTAXY OF SARCOPTIFORM FEATHER MITES (Acarina: Analgoidea)[1, 2]

WARREN T. ATYEO[3] AND J. GAUD[4]

The current nomenclature for the Sarcoptiformes is based primarily on Zakhvatkin (1941) for the idiosomal chaetotaxy and Grandjean (1939) for the leg chaetotaxy. The authors have adapted these systems for feather mites considering the following criteria: stability—employing established terms whenever possible; compatability—homologizing known morphological structures within the Sarcoptiformes; and applicability—using terminology easily translatable into various languages without modification.

Zakhvatkin (1941) established a nomenclatural system for the idiosomal chaetotaxy of the Tyroglyphoidea which was based in part on pre-existing systems. Even with its inconsistencies, Zakhvatkin's nomenclature has been employed extensively in sarcoptiform systematics. The proposed modification of this nomenclature has been used successfully for many genera of feather mites by the authors and for genera of the Psoroptidae by Fain (1963).

GNATHOSOMAL CHAETOTAXY

This section is based on the unpublished investigations of Dr. Donald E. Johnston (Institute of Acarology, Wooster, Ohio) on the comparative morphology of acarine mouthparts. The gnathosoma, consisting of the subcapitulum, chelicerae, and palpi bears six pairs of tactile setae and one pair of solenidia. The subcapitulum bears one pair of *subcapitular setae* lateral to the base of the ~~ventral labrum~~ and one pair of *supracoxal setae* on the dorsolateral surface. Each chelicera bears one elongate *paraxial seta* at the base of the fixed digit. Lastly, each palpus bears one ventral and two dorsal setae and one apical solenidion.

Hypotrime

IDIOSOMAL CHAETOTAXY

Dorsal Propodosoma

Maximally there are four pairs of setae. The most conspicuous are the long external scapular setae (*se*) (sensilla of authors) and the

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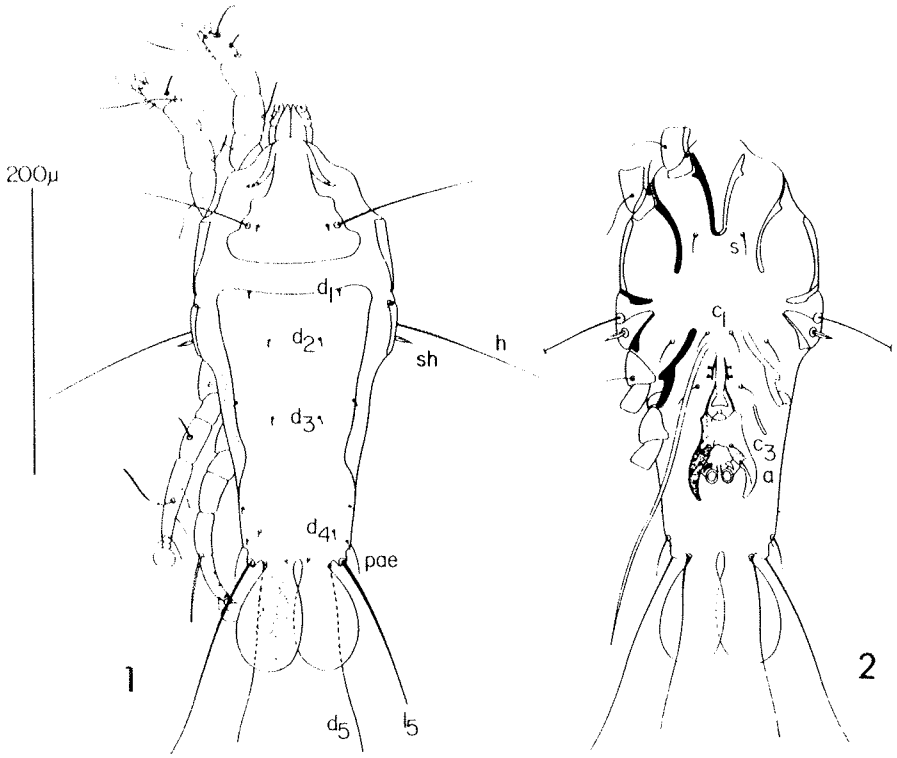
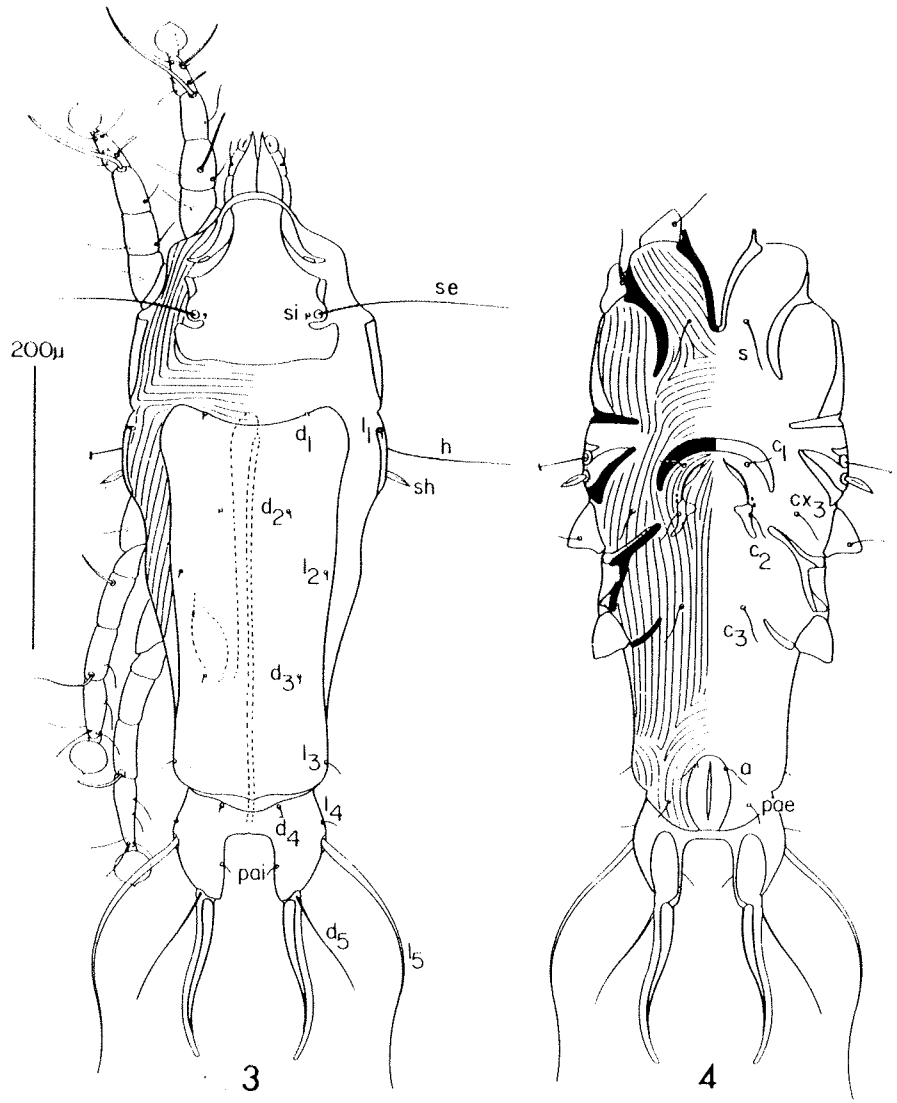


FIGS. 1, 2: *Proctophyllodes glandarinus* (Koch), dorsal and ventral aspects of male. See text for explanation of figures.

smaller internal scapular setae (*si*). These setae form a transverse row on the posterior margin of the propodosoma. Near the apex of the propodosoma, there are two, one, or no internal vertical setae (*vi*) (vertical setae of authors) and posterolateral to these setae and inserted on or near the edge of the propodosomal shield, are the external vertical setae (*ve*). These latter are apparently wanting in most feather mites or because of their minute size have been overlooked.

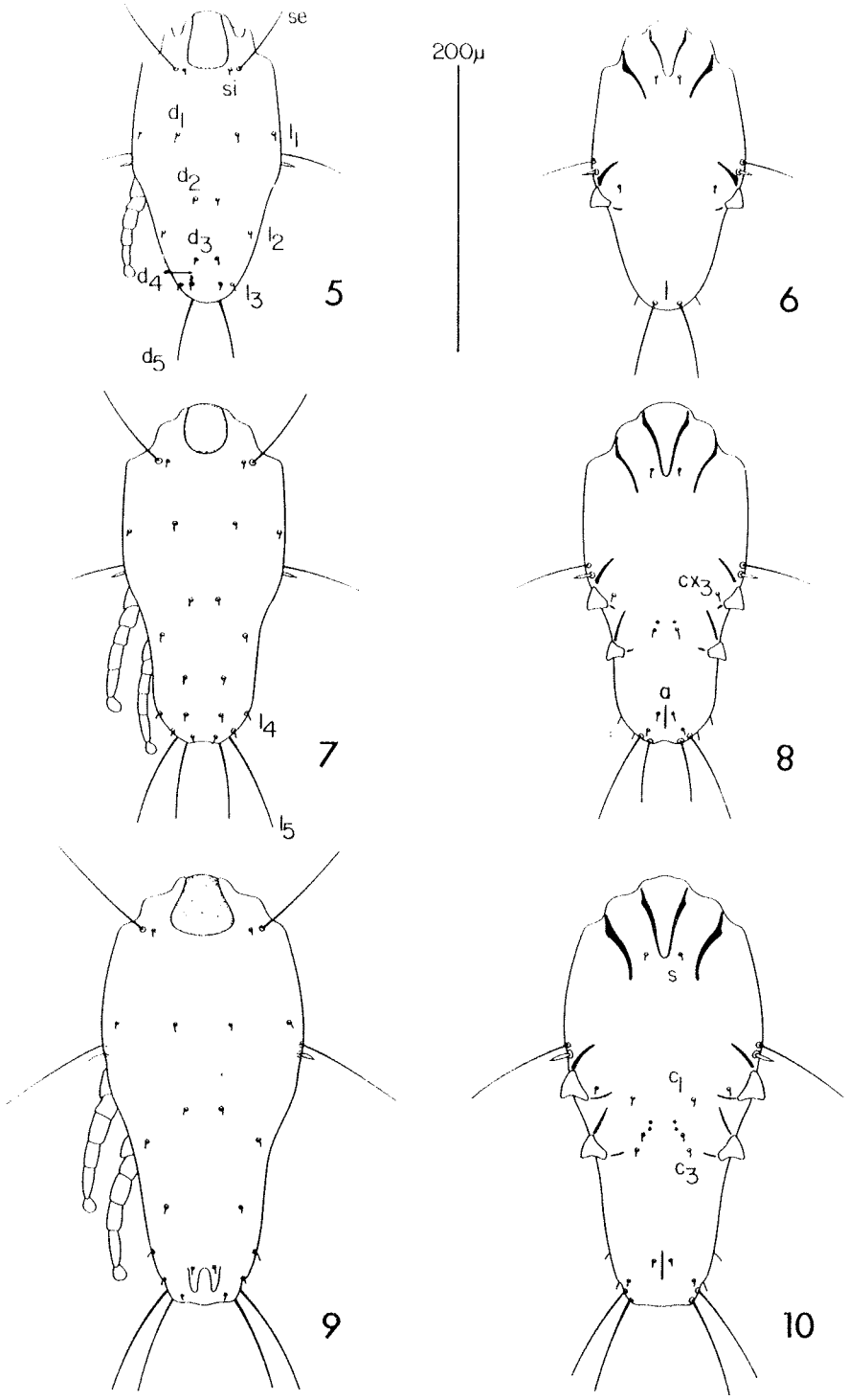
Dorsal Hysterosoma

Anterolaterally two pairs of conspicuous setae are always present: the long humeral setae (*h*) and the shorter, variously modified subhumeral setae (*sh*). In the Proctophyllodidae the subhumeral setae are inserted posteroventral to the humeral setae, but in other groups of feather mites, the subhumeral setae are ventral, anteroventral, or anterior to the humeral setae. These setae are associated with the humeral shield and it is believed that the subhumeral setae, at least, are coxal in origin.



FIGS. 3,4: *Proctophyllodes glandarinus* (Koch), dorsal and ventral aspects of female. See text for explanation of figures.

Five horizontal or curved rows of setae, each row consisting of an internal pair (d) and an external pair (l), are arranged from the anterior margin of the hysterosoma to the termination of the idiosoma and are designated respectively d_{1-5} and l_{1-5}. These rows are easily observable in species with a rather simple body form and in the immature stages. In the latter, the setae of each row tend to follow integumental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striation patterns. Difficulties in recognizing the various setae occur in the specialized forms in which the terminal portions of the hysterosoma are elongated or otherwise modified.

To establish the chaetotaxal relationships, the following hypotheses have been employed:

1. There are maximally ten pairs of dorsal hysterosomal setae.
2. The setae are arranged in five horizontal or curved rows of four setae each.
3. Each row consists of one pair of dorsal setae (d) and one pair of lateral setae (l).
4. The relative positions of these setae within a genus are constant.
5. If less than ten pairs of setae are present, the missing setae tend to be the internal pair of the anterior row (d_1) or the lateral pairs of the second, third, or fourth rows (l_{2-4}).
6. The fifth row of setae are usually terminal and highly modified.
7. The dorsolateral hysterosomal glands open between the lateral setae of the second and third rows (l_{2-3}).

Two additional pairs of setae, the postanal setae, have shifted from subterminal to dorsal, posterolateral or ventrolateral positions. The internal postanal setae (*pai*) are inserted mesal or anteromesal to setae d_5. The external postanal setae (*pae*) in males are positioned immediately ventral to setae l_4, while in females, these setae are ventral and usually located on a line extending from the terminal portion of the anus to setae l_4. In most genera, the internal postanal setae are minute and the external postanal setae are large and conspicuous

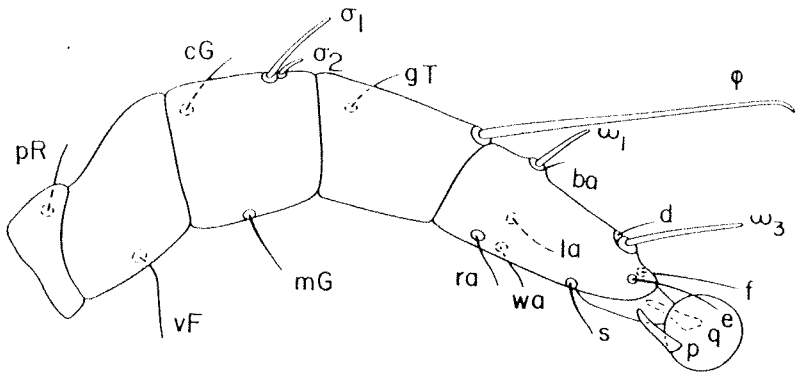
Ventral Idiosoma

Excluding the postanal setae, six pairs of setae are positioned on the venter of the adult feather mite: one pair of sternal setae (s) on coxae I, one pair of coxal setae (cx_3) on coxae III, three pairs of central setae (c_{1-3}), and one pair of adanal setae (a). The sternal and coxal setae are constant in position and are located, respectively, lateral to the anastomsis of epimerites I and in the coxal area delimited by epimerites III and III*a*. The adanal setae are posterior and may be near the anal orifice or lateral, or posterolateral to the adanal discs.

The three remaining pairs of setae, the centrals (genitals of Fain, 1963) are variable in position between genera and between sexes of the same species. Two pairs of central setae are associated with the genital discs in the nymphal states and could well be termed genital setae. However, in the adult mite, especially in the male, secondary positions may obscure the relationships of these setae. In genera characterized by the extreme anterior positions of the genitalia, there is some ques-

←

FIGS. 5–10: Developmental stages of *Proctophyllodes* species: dorsal and ventral aspects of larva (5, 6), protonymph (7, 8), and female tritonymph (9, 10).



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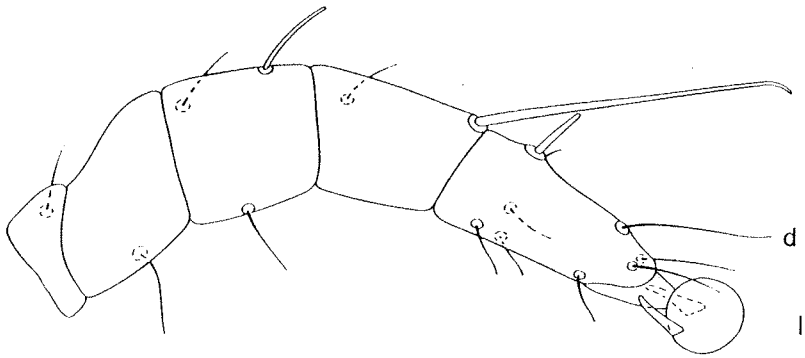
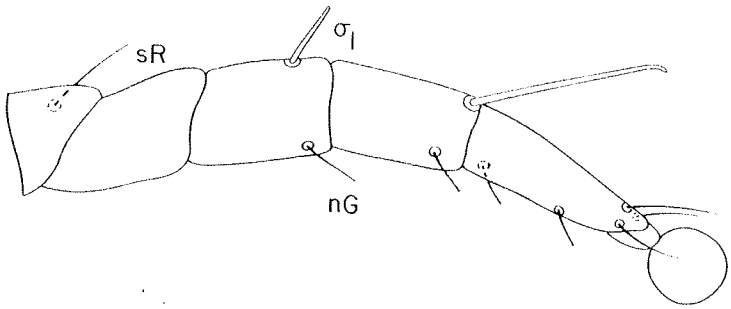
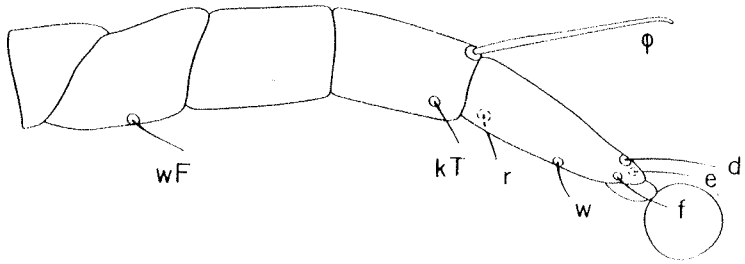


12 II



13 III



14 IV

tion as to which setae remain in the nymphal positions and which setae shift. Therefore, even though it is usually possible to associate two pairs of ventral setae with the genital discs, topographical notations are used to avoid needless controversy which could arise in comparing highly modified forms.

In females, the anterior two pairs of central setae are usually positioned approximate to the atrophied genital discs as in the tritonymphal stage. The posterior setae (c_3) are usually between lines connecting the anterior and posterior articulations of legs IV, but they may be positioned near the meson or on the coxal field of leg IV.

In males, there is little direct relationship between the positions of the central setae and the genital discs. Probably the anterior pair (c_1) could be assumed to be the setae arising with the anterior pair of genital discs, and often the second pair (c_2) is approximate to the second pair of genital discs. However, in modified forms, setae c_2 and c_3 are distant from the genital discs.

Developmental Chaetotaxy

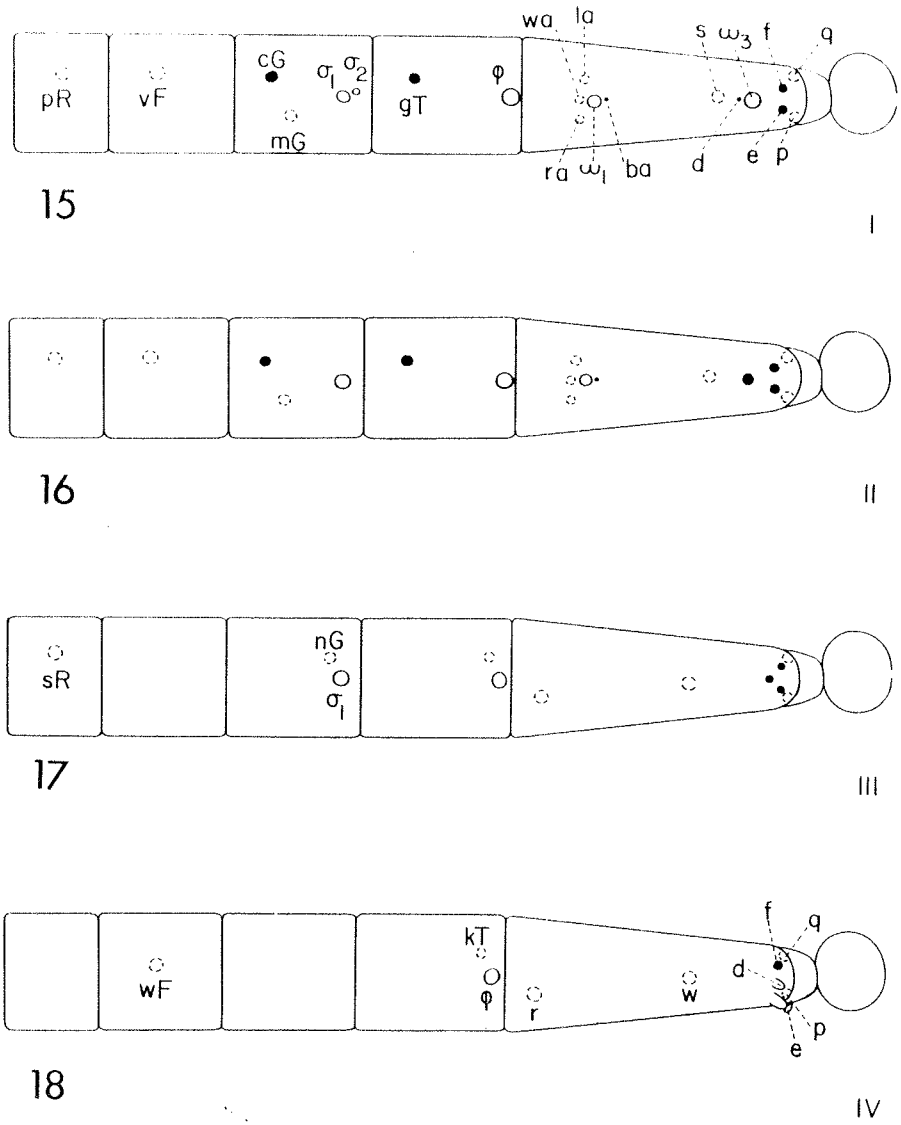
Omitting the dorsal propodosoma, humeral, and subhumeral setae, there are maximally eighteen pairs of idiosomal setae: ten pairs associated with the dorsal hysterosoma, two pairs of postanal setae, and six pairs of ventral setae. Based on the studies of *Proctophyllodes* (Atyeo and Braasch, 1966), specific setae and genital structures absent in the larval instar are added with each developmental stage.

Considering that in the genus *Proctophyllodes* all of the eighteen pairs of setae are present in the adult, this genus may be used as an example for the discussion of the developmental chaetotaxy. In the larva, setae l_4, l_5, *pae, pai, a,* and c_{1-3} and the genital structures are absent. In the protonymph, the majority of these setae plus one pair of genital discs appear, these are: l_4, l_5, *pae, pai, a,* and c_2 (or c_1). Thus, during the protonymphal stage, only setae c_1 and c_3 and one pair of genital discs are absent. In the tritonymphal stage, the ventral setae and genital discs have attained the maximal number, that is, six pairs of ventral setae and two pairs of genital discs. By observing the number of genital discs and associated setae, it is possible to determine the nymphal instar—one pair of genital discs and one pair of associated setae in the protonymph and two pairs of genital discs and two associated pairs of setae in the tritonymph.

In the adult the genitalia appear, but also, there is a considerable shifting of the adanal setae, the three pairs of central setae, and in many instances, a shifting of the genital discs from their nymphal positions between the legs III and IV.

←

FIGS. 11–14: Antaxial (postaxial) aspects of legs I–IV.



FIGS. 15–18: Schematic dorsal aspects of legs I–IV. Dorsal tactile setae represented by solid black circles, dorsal solenidia by white circles, ventral tactile setae by dotted circles.

LEG CHAETOTAXY

The chaetotaxy of the legs is remarkably uniform within the Sarcoptiformes; however, interfamial and intergeneric differences suggest that chaetotaxy will serve as an important criterion in delimiting supra-

specific taxa. Current taxonomic research dealing with sarcoptiform groups follow the nomenclature outlined by Grandjean (1939). According to this system, each seta is positioned on a specific surface and in a fixed position relative to the complete setal complement. Grandjean places emphasis on the orientation of the legs to the axis of the idiosoma; a surface directed toward the meson is the paraxial surface and the opposite face is the antaxial surface. Thus, seta *f* on legs I and II is inserted on the paraxial surface and on legs III and IV is inserted on the antaxial surface. Schematic dorsal aspects of legs I–IV are presented for purposes of orientation (Figs. 15–18).

Comparing the leg chaetotaxy of feather mites with the general considerations of Grandjean and the recent investigations of the Tyroglyphidae by Griffiths (1964) and Hughes (1961), it can be stated that the sarcoptiform feather mites are characterized by the lack of specific setae normally present within the Acaridiae. Specifically, setae that have not been observed are: leg I, *hT*, *omega*$_2$, famulus *epsilon*, *aa*, *u*, *v*; leg II, *hT*, *u*, *v*; leg III, *nG*, *u*, *v*; leg IV, *wF*, *u*, *v*. Except for a few comments, the nomenclature is evident from the figures presented herein or from the figures in the cited investigations.

Within the feather mites, all of the setae illustrated may not be present within a genus or subfamily. The two subapical setae *p* and *q* ("expansions juxta-ambulacraires" of Gaud and Mouchet) are of especial importance and their presence or absence may be characteristic of higher taxa. Typically, each of these setae appears as a large fanlike structure without an alveolus and without a lumen (neither bifurcate nor alveolate as interpreted by Dubinin, 1956, Figs. 117, 213). A reduction in development through various genera is culminated in *Montchadskiana* in which setae *p* and *q* appear as small, parallel-sided spines.

Seta *ba*, if present, is in the position normally occupied by the famulus (ϵ). This conclusion is based on the presence of a small seta at the base of solenidion ω_1 on tarsus I and II. If this seta were homologous to the famulus, it would be restricted to tarsus I.

According to genus, setae other than *ba*, *p*, and *q* may be absent or highly modified. The solenidia σ_2 on genu I, σ_1 on genua II and III, and seta *r* on tarsus IV may be absent. Setae *d* and *e* on tarsus IV of the males may be modified as short spines or minute copulatory discs. In the latter case, the disc homologous to seta *d* may be incomplete.

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ADDENDUM

There are lessons to be learned from the history of the development of the preceding ideas. In 1962 and the first half of 1963, I attempted to apply pre-existing systems of chaetotaxal nomenclature to the sarcoptiform feather mites. Although not wholly satisfactory, a working hypothesis was formulated. This hypothesis was explained in detail to Dr. Alex Fain and Dr. Jean Gaud early in the summer of 1963 in hopes that a stable system could be developed, tested on many and varied groups of mites, and *then* published.

A few weeks later, Dr. G. Owen Evans demonstrated to me that in addition to one pair of anal setae, there were *two* pairs of postanal setae which could shift considerably in position in adult mites. This demonstration was the key which explained discrepancies in my working hypothesis, namely that there were three, not two pairs of posteroventral setae. The correct signatures were given to Gaud and since that time, Gaud (1965) and Atyeo and Braasch (1966) have successfully applied them to many genera of feather mites. The corrected system was not given to Fain.

In the fall of 1963, Fain published a system for the idiosomal chaetotaxy of sarcoptiform mites ". . . inspiré en partie de données fournies par le Dr. W. T. Atyeo (comm. verb.)." (Fain's contribution to the working hypothesis was to change the designations of setae $c_{1\text{-}3}$ to setae *ga, gm, gp*.) However, Fain, in his haste to publish, failed to realize that he was using an incorrect and unsatisfactory system. It is interesting to read Fain's (1965) defense of his system as his lines of reasoning necessarily negate evolution.

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W.T.A.

Appendix 2:Mites occurring on ducks,excluding the Freyanidae (Gaud,pers.comm.).

Superfamily Analgoidea,Fam Alloptidae,Sub-fam. Alloptinae

g.Brephosceles,Hull 1934;type:Pterolichus forficiger M.and Trt 1884

Brephosceles anatina Dubinin 1951,on Anas platyrhynchos

Brephosceles discidius Peterson 1971,on Cugnus bewecki

Brephosceles lambda (Pterocolus lambda,Trt 1885;Alloptes lambda, Canestrini and Kramer 1899),on Nettapus auritus.

g.Heterobrephosceles,Peterson and Atyeo 1977;type:H.rapiformis

H.rapiformis Peterson and Atyeo 1977,on Tadorna rajah

H.megathrix Peterson and Atyeo 1977,on Dendrocygna javanica

H.scissus (Proctophyllodes(Alloptes)scissus Trt 1886;Brephosceles scissus,Park and Atyeo 1975),initial host described as a Trochilidae,Eutoxeres aquila,but the real host without any doubt an Anatidae.

Fam.Alloptidae,sub-fam. Oxyalginae

g.Alloptoides,Gaud 1961;type:Alloptoides acanthodiscus

A.acanthodiscus Gaud 1961,on Sarcidiornis melanonotos

A.aythinae (Brephosceles aythinae Dubinin 1951)on Netta rufina

A.gynurus (Alloptes gynurus Trt 1886:Brephosceles gynurus Gaud and Till 1961) on Chenalopex aegyptiaca.

?? g.Alloptellus Dubinin 1955;type:Alloptellus pelecanus,Dubinin 1955

A.dendrocygni,Dubinin 1955=nomen nudum

Superfam. Analgoidea,Fam. Avenzoariidae,Sub-fam. Bonnetellinae

g.Bdellorhynchus,Trt 1885;type:B.polymorphus

B.oxyurae Dubinin 1956,on Oxyura leucocephala

B.polymorphus Trt 1885,on Anas crecca

(B.affinis Dub. 1953 on Anas rhynchotis and B.australis on Nettapus coromandelianus=nomina nuda.)

g.Zygochelifer,n.g. ;type:Bdellorhynchus psalidurus Trt 1886, on Chenalopex aegyptiaca.

Superfam. Pterolichoidea,Fam.Rectijanuidae

g.Rectijanua ,Gaud 1961 ;type:R. radfordi Gaud 1961

R. braaschi A. and Peterson 1976,on Aythia collaris.

R. graciliora A. and Peterson 1976,on Dendrocygna viduata.

R. grebenjukii Chirov 1977,on Netta rufina.

R. oxyurae A. and Peterson 1976,on Oxyura dominica.

R. radfordi Gaud 1961,on Pteronetta hartlaubi.

R. striata A. and P. 1976,on Dendrocygna javanica.

R. sublobata A. and P. 1976,on Sarcidiornis melanonota.

Appendix 3: Breeding attempts in Serendip during 1980-1981.

Nestboxes no. 49,50,52-59 were used in the experiment.No ducks,birds or eggs were recorded for boxes no. 49,50,52,53,55,58.

The results of fortnightly checks for the other boxes were as follows:

Box 54:Seven eggs were present on the 29th of oktober,on the 2nd of november six eggs were still there and two new eggs. On the 26th of november two eggs from the 29th of oktober and 2nd of november were rotten and had to be destroyed. No ducklings hatched.

Box 56:Three eggs were present at the 12th of november but no ducklings hatched.

Box 57:Six eggs were present at the 20th of august of which four eggs were left at the 3rd of september.On the 1st of oktober four new eggs were present of which three were left at the 15th of oktober with two new eggs.At the 26th of november two new eggs were present.Three eggs of the 20th of august had to be destroyed on the 17th of september and the 1st of oktober.No ducklings hatched.

Box 59:Two eggs were present on the 3rd of september of which one was left at the 17th of september together with a new one.At the 5th of oktober one egg had to be destroyed and no ducklings hatched.

No starlings or sparrows were recorded either.