Menopon, Menacanthus, Holomenopon
(insect: louse)

Overview

Arthropods are coelomate metameric invertebrate animals with a chitinous exoskeleton and jointed limbs. They undergo protostomial embryonic development and grow by cuticular moulting (ecdysis). Three main subphyla are recognized: Chelicerata, Crustacea and Hexapoda. Insects are hexapods with three pairs of uniramous legs, three tagmata (head, thorax, abdomen), ectognathous mouthparts with whole-limb mandibles, and one pair of antennae. Lice (Phthiraptera) are small wingless dorsoventrally-flattened hemipterodeans which are permanent obligate ectoparasites on other animals. All lice undergo gradual metamorphosis and there are no free-living stages. Eggs are cemented to host hairs whereas nymphs and adults cling to hairs using enlarged tarsal claws. Lice do not survive long off their hosts so transmission is usually by direct contact. Mallophagan (chewing) lice have blunt rounded heads with mouthparts adapted for feeding on keratin in superficial skin layers. Chewing lice are ectoparasitic on mammals and birds, most species being highly host specific and even site-specific. Amblyceran lice have maxillary palps and four-segmented antennae located in grooves. Menoponids occur on birds and infestations by *Menopon, Holomenopon* and *Menacanthus* spp. have been associated with restlessness, damaged plumage and reduced productivity in poultry and gamebirds.

Classification:

Domain:	Eukaryota (membrane-bound nucleus)
Supergroup:	Amorphea (unikonts with single flagellum, or nonflagellated amoebae)
Kingdom:	Metazoa (multicellular eukaryotes, heterotrophs, notably animals)
Group:	Protostomia (triploblastic, spiral cleavage)
Subgroup:	Ecdysozoa (cuticle moulted = ecdysis)
Phylum:	Arthropoda (chitinous exoskeleton, segmented body, jointed limbs, haemocoel)
Subphylum:	Hexapoda (three tagmata, three pairs uniramous legs, whole-limb mandibles, Malpighian tubules)
Class:	Insecta (ectognathous mouthparts (bases lie outside head capsule), single pair antennae, many with wings)
Superorder:	Hemipterodea (Exopterygota) (young resemble adults, externally developing wings)
Order:	Phthiraptera (lice, wingless, ectoparasites, dorsoventrally flattened, stout legs, claws, eggs, nymphs, adults)
Suborder:	Mallophaga (= wool-eating) (chewing lice, broad rounded head, feed on keratin, host/site specific)
Superfamily:	Amblycera (with maxillary palps, large rounded heads, 4-segmented antennae in antennal grooves)
Family:	Menoponidae (parasitize birds)
Genus:	*Menopon* (parasitic on skin/feathers of birds)
Genus:	*Holomenopon* (parasitic on skin/feathers of birds)
Genus:	*Menacanthus* (parasitic on skin/feathers of birds)
Species:	various species cause restlessness and reduced productivity in poultry and gamebirds

Parasite biodiversity and host range: Most Metazoa are multicellular triploblastic animals with differentiated tissues, many being bilaterally symmetrical with a body cavity. Most invertebrate animals are protostomes as their embryonic development involves spiral determinate cleavage. Those that moult their external cuticles during their life-cycles (process known as ecdysis) are grouped together in the unique clade Ecdysozoa, including the nematodes (roundworms), onychophorans (velvet worms), tardigrades (water bears) and arthropods (myriapods, chelicerates, crustaceans and hexapods). Arthropods have small segmented bodies encased in chitinous exoskeletons with articulated limbs. Most species are free-living in terrestrial and aquatic habitats, although a small range are ectoparasitic on other animals, some feeding on the blood or skin of vertebrates. Five subphyla are recognized: Chelicerata, Crustacea, Hexapoda, Myriapoda and Trilobita. Insects are hexapods with six legs, three distinct body parts, two antennae and mouthparts with whole-limb mandibles. Insects are the most biodiverse group on the planet, with millions of species described in numerous taxa. Notorious ectoparasitic species belong to four orders in two superorders: the Hemipterodea (Exopterygota) containing the orders Hemiptera (bugs) and Phthiraptera (lice); and the Holometabola (Endopterygota) containing the orders Siphonaptera (fleas) and Diptera ('true' flies). Lice are small wingless hemipterodeans that undergo gradual (hemimetabolous) metamorphosis and are permanent obligate ectoparasites on other animals. Four suborders are recognized: the Anoplura containing the haematophagous sucking lice of placental mammals; the Ischnocera and Amblycera (previously classified together as Mallophaga) comprising the chewing or biting lice of birds, marsupials and placental mammals; and the Rhynchophthirina confined to elephants and warthogs in Africa.

Major parasitic phthirapteran families	Biodiversity	Hosts	Parasitic stages	Patho-genesis	Disease transmission
Suborder: Amblycera [Mallophaga p.p.] (chewing lice of mammals and birds, large rounded head, with maxillary palps, 4-segmented antennae in antennal grooves, keratin feeders) [6 families, 96 genera, 1,550 species]					
Menoponidae (bird lice)	68 genera, 1,150 spp.	birds	nymphs, adults	biting, chewing	-
Boopiidae (marsupial chewing lice)	8 genera, 57 spp.	mammals (incl. marsupials)	nymphs, adults	biting	helminth
Suborder: Ischnocera [Mallophaga p.p.] (chewing lice of mammals and birds, broad rounded head, without maxillary palps, prominent filiform antennae, keratin feeders) [2 families, 158 genera, 3,371 species]					
Trichodectidae (fur lice)	20 genera, 413 spp.	mammals (bovids, equids, carnivores)	nymphs, adults	biting	helminth
Philopteridae(bird lice)	138 genera, 2,958 spp.	birds	nymphs, adults	biting, chewing	-
Suborder: Rhynchophthirina (sucking lice of African wildlife) [1 family, 1 genus, 4 species]					
Haematomyzidae (elephant & warthog lice)	1 genus, 4 spp.	mammals (elephants, warthogs)	nymphs, adults	blood-sucking	-
Suborder: Anoplura (sucking lice of placental mammals) (narrow pointed head, pierce skin and feed on fluids (solenophagy)) [16 families, 51 genera, 694 species]					
Haematopinidae (ungulate lice, short-nosed lice)	1 genus, 21 spp.	mammals (equids, bovids, suids)	nymphs, adults	blood-sucking	viral, bacterial
Linognathidae (pale lice, long-nosed lice)	3 genera, 73 spp.	mammals (bovids, canids)	nymphs, adults	blood-sucking	-
Pediculidae (head & body lice)	1 genus, 4 spp.	mammals (hominids, New World primates)	nymphs, adults	blood-sucking	bacterial
Pthiridae (pubic lice)	1 genus, 2 spp.	mammals (hominids)	nymphs, adults	blood-sucking	-

Over 4,900 species of biting/chewing lice have been described in 253 genera in 8 families, around 4,400 species associated with birds and 500 species with mammals. Members of the suborder Ischnocera have broad rounded heads with conspicuous filiform antennae but lacking maxillary palps, while members of the suborder Amblycera have large rounded heads with maxillary palps and inconspicuous antennae hidden in grooves. Some 158 ischnoceran genera have been assigned to 2 families (Trichodectidae and Philopteridae), while 96 amblyceran genera have been classified in 6 families (Boopiidae; Gyropidae, Laemobothriidae, Menoponidae, Ricinidae, Trimenoponidae). Species of veterinary importance include members of the ischnoceran families Trichodectidae (bovids, canids, equids) and Philopteridae (poultry), and the amblyceran families Menoponidae (poultry) and Boopiidae (carnivores). Members of the family Menoponidae are parasitic on birds and have 6 pairs of abdominal spiracles with 2 segments between the thorax and first abdominal segment bearing spiracles (whereas members of the family Boopiidae are parasitic on mammals and also have 6 pairs of abdominal spiracles but only one segment between the thorax and the first abdominal segment bearing spiracles). Some 1,150 menoponid species have been described from 68 genera, namely *Actornithophilus*, *Afrimenopon*, *Amyrsidea*, *Ancistrona*, *Apterygon*, *Ardeiphilus*, *Austromenopon*, *Bonomiella*, *Bucerocolpocephalum*, *Bucerophagus*, *Cavifera*, *Chapinia*, *Ciconiphilus*, *Clayia*, *Colimenopon*, *Colpocephalum*, *Comatomenopon*, *Coramenopon*, *Ctenigogus*, *Cuculimenopon*, *Cuculiphilus*, *Dennyus*, *Dicteisia*, *Eidmanniella*, *Elbelia*, *Eomenopon*, *Epiara*, *Eucolpocephalum*, *Eureum*, *Falcomenopon*, *Franciscoloa*, *Fregatiella*, *Gruimenopon*, *Heleonomus*, *Heterokodeia*, *Heteromenopon*, *Hoazineus*, *Hohorstiella*, *Holomenopon*, *Kaysius*, *Kelerimenopon*, *Kurodaia*, *Longimenopon*, *Machaerilaemus*, *Menacanthus*, *Menopon*, *Meromenopon*, *Microctenia*, *Mimemamenopon*, *Myrsidea*, *Neomenopon*, *Nosopon*, *Numidicola*, *Odoriphila*, *Osborniella*, *Pacifimenopon*, *Piagetiella*, *Plegadiphilus*, *Podargiphilus*, *Pseudomenopon*, *Psittacobrosus*, *Psittacomenopon*, *Pterophilus*, *Quateia*, *Rediella*, *Somaphantus*, *Trinoton*, and *Turacoeca*. Many species have been recorded from domestic birds (especially galliform and anseriform birds), while other species have been found on wild, game and aviary birds. Most species are thought to be host-specific, or to occur on closely-related hosts. Many species have also been found to be site-specific and only occur on particular body parts in association with particular feathers. In particular, some 13 *Menopon* spp. have been found on the feathers of domestic fowl, 16 *Holomenopon* spp. on the skin and feathers of waterfowl, and 96 *Menacanthus* spp. on the skin of domestic and game birds as well as numerous aviary perching birds. Infestations have been recorded around the world in most zoogeographic regions.

***Menopon* species**	**Hosts**	**Location**	**Distribution**
M. carrikeri	Galliformes: phasianid (Sumatran peacock-pheasant)	feathers	Indonesia
M. clayae	Galliformes: phasianid (Palawan peacock-pheasant)	feathers	Philippines
M. deryloi	Galliformes: phasianid (black grouse)	feathers	Europe
M. ferrisi	Galliformes: phasianid (mountain peacock-pheasant)	feathers	Malaysia
M. gallinae (syn. *M. brevipes, longicephalum, lunanale, pallidum, productum, trigonocephalum*) (shaft louse)	Galliformes: phasianid (chicken, turkey, ferruginous partridge, silver pheasant, brown-eared pheasant, Mikado pheasant, Bulwer's pheasant, Swinhoe's pheasant, Kalij pheasant, Siamese fireback, crested fireback, crestless fireback, grey junglefowl, Sri Lankan jungle-fowl, helmeted guineafowl, Satyr tragopan), Columbiformes: columbid (pigeon)	feathers (thigh, breast)	worldwide
M. hopkinsi	Galliformes: phasianid (Malay peacock-pheasant)	feathers	Malaysia
M. interpositum	Galliformes: phasianid (grey francolin)	feathers	South Asia
M. jellisoni	Galliformes: phasianid (Ceylon spurfowl)	feathers	Sri Lanka
M. kuntzi	Galliformes: phasianid (bamboo partridge)	feathers	Asia
M. pallens (syn. *M. pallascens*)	Galliformes: phasianid (Barbary partridge, rock partridge, red-legged partridge, grey partridge)	feathers	Europe, Africa
M. spinulosum	Galliformes: phasianid (Burmese peacock-pheasant)	feathers	Asia
M. subgallinae	Galliformes: phasianid (green jungle-fowl)	feathers	Indonesia

***Menacanthus* species**	**Hosts**	**Location**	**Distribution**
M. abdominalis	Galliformes: phasianid (common quail)	skin	Europe
M. aburris	Galliformes: cracid (wattled guan)	skin	South America
M. aeedonis	Passeriformes: troglodytid (Bewick's wren, house wren)	skin	Americas
M. affinis	Passeriformes: turdid (northern wheatear)	skin	Eurasia, North America
M. agilis (syn. *M. phylloscopi*)	Passeriformes: muscicapid (spotted flycatcher), sylviid (Tickell's leaf warbler, common chiff-chaff, willow warbler), turdid (common redstart, black redstart)	skin	Eurasia, Africa
M. alaudae (syn. *M. alaskensis, cannabinae, carduelis, citrinellae, mongolicus, parviceps, perforatus, stiefeli*)	Passeriformes: cinclid (American dipper), fringillid (pine grosbeak, common linnet, common redpoll, twite, European goldfinch, American goldfinch, pine siskin, common rosefinch, housefinch, Pallas's rosefinch, Asian rosy finch, pine grosbeak), alaudid (Eurasian skylark, horned lark, crested lark), emberizid (black-throated sparrow, yellowhammer, chestnut-eared bunting, snow bunting), icterid (eastern meadowlark, western meadowlark), ploceid (white-browed sparrow-weaver)	skin	Eurasia, Africa, Americas
M. albicans	Galliformes: phasianid (kalij pheasant)	skin	Himalayas
M. albicaudus	Galliformes: cracid (band-tailed guan)	skin	South America
M. annuliventer	Galliformes: cracid (blue-billed curassow)	skin	South America
M. arctifasciatus	Tinamiformes: tinamid (spotted nothura, red-winged tinamou)	skin	South America
M. aurocapillus	Passeriformes: parulid (black-and-white warbler, orange-crowned warbler, Colima warbler, ovenbird, northern waterthrush, Louisiana waterthrush)	skin	Americas
M. balfouri	Piciformes: ramphastid (yellow-throated toucan, white-throated toucan, Choco toucan, green-billed toucan, keel-billed toucan, channel-billed toucan, chestnut-mandibled toucan)	skin	South America
M. boliviensis	Galliformes: phasianid (marbled wood quail)	skin	South America
M. brachygaster	Tinamiformes: tinamid (grey tinamou)	skin	South America
M. brevispinus	Galliformes: phasianid (stripe-faced wood quail)	skin	South America
M. camelinus (syn. *M. aequalis, brevidentatus, dudiyalatora, guldum, inequalis, setosus*)	Passeriformes: laniid (great grey shrike, lesser grey shrike, red-backed shrike, brown shrike, loggerhead shrike, masked shrike, long-tailed shrike, woodchat shrike, bay-backed shrike, Chinese grey shrike, Burmese shrike)	skin	Eurasia, Africa
M. campephili	Piciformes: picid (Magellanic woodpecker)	skin	South America
M. caudatus	Piciformes: galbulid (rufous-tailed jacamar)	skin	Central and South America

M. chaparensis	Galliformes: cracid (Spix's guan)	skin	South America
M. chrysophaeus (syn. *M. spodocephalae*)	Passeriformes: emberizid (black-faced bunting, swamp sparrow, song sparrow, savannah sparrow, fox sparrow, American tree sparrow, field sparrow)	skin	Eurasia, North America
M. cincinnatus	Galliformes: cracid (sickle-winged guan)	skin	South America
M. colinus	Galliformes: phasianid (crested bobwhite)	skin	South America
M. coniceps	Tinamiformes: tinamid (little tinamou)	skin	South America
M. cornuceps	Galliformes: cracid (sickle-winged guan, band-tailed guan, crested guan, black curassow)	skin	Central and South America
M. cornutus	Galliformes: phasianid (chicken)	skin	Asia
M. crateropus	Passeriformes: leiothrichid (southern pied babbler, arrow-marked babbler)	skin	Africa
M. curuccae (syn. *M. mauersbergi, verecundus, vistulanus, wegelini*)	Passeriformes: sylviid (thick-billed warbler, great reed warbler, aquatic warbler, sedge warbler, willow warbler, garden warbler, barred warbler, common whitethroat, lesser whitethroat, Eurasian blackcap), vireonid (yellow-throated vireo, white-eyed vireo, red-eyed vireo, blue-headed vireo)	skin	Eurasia, Africa, Americas
M. daubentoni	Galliformes: cracid (yellow-knobbed curassow)	skin	South America
M. dendroicae	Passeriformes: parulid (prairie warbler, yellow-rumped warbler)	skin	North America
M. dennisi	Passeriformes: cracticid (grey currawong)	skin	Australia
M. distinctus	Passeriformes: tyrannid (Euler's flycatcher, ash-throated flycatcher, dusky-capped flycatcher, brown-crested flycatcher, greyish mourner)	skin	Americas
M. eichleri	Galliformes: phasianid (rock partridge)	skin	Europe
M. eisenachensis	Passeriformes: sylviid (reed warbler)	skin	Eurasia, Africa
M. elbeli	Passeriformes: artamid (ashy wood swallow, great wood swallow)	skin	India, Asia
M. eurysternus (syn. *M. annulatus, biaculeatus, brelihi, chabaroviensis, cornicis, dicruri, difficilis, dubius, festivus, flavus, fuscocinctus, germanus, gracilis, grandis, gulabimaina, himalayicus, inscitus, kevei, meniscus, microsceli, minisculus, monochromateus, mutabilis, parvulus, persignatus, pflegeri, picae, pius, polonicus, pyrrhulae, remizae, safedgal, schildmacheri, sittae, spiniferus, spinosus, subspinosus, tibialis, tichodrome, translucidus, tristisi, turkmeniscus, volkovi, wipszyckii*)	Passeriformes: bombycillid (northern phainopepla), cardinalid (rose-breasted grosbeak, vermilion cardinal), chloropseid (golden-fronted leafbird, blue-winged leafbird, yellow-throated leafbird, greater green leafbird), cisticolid (rufous-tailed tailorbird), corvid (carrion crow, western jackdaw, Eurasian jay, Florida scrub jay, blue jay, Steller's jay, black-headed jay, plush-crested jay, green jay, white-collared jay, Eurasian magpie, azure-winged magpie, yellow-billed magpie, Clark's nutcracker, piapiac, alpine chough), dicrurid (ashy drongo, black drongo, white-bellied drongo, hair-crested drongo, greater racket-tailed drongo, lesser racket-tailed drongo), emberizid (chestnut-capped brushfinch, rufous-winged sparrow, fox sparrow, Lapland longspur, northern cardinal, black-faced bunting, cinnamon-breasted bunting), estrildid (African silverbill, Indian silverbill, scaly-breasted munia, green-winged pytilia), fringillid (common redpoll, European greenfinch, red siskin, common chaffinch, Eurasian bullfinch, canary, streaky seedeater), grallariid (tawny antpitta, chestnut-crowned antpitta), icterid (red-winged blackbird, scarlet-headed blackbird, Baltimore oriole, bronzed cowbird, brown-headed cowbird, common grackle), irenid (Asian fairy-bluebird), laniid (red-backed shrike, brown shrike, long-tailed shrike), leiothrichid (Taiwan barwing, Nilgiri laughingthrush, chestnut-crowned laughingthrush), meliphagid (red wattlebird, New Zealand bellbird, New Holland honeyeater, tawny-breasted honeyeater, tui), mimid (tropical mockingbird, northern mockingbird, Bendire's thrasher, California thrasher, brown thrasher), motacillid (Australasian pipit, forest wagtail), muscicapid (Narcissus flycatcher, large niltava, Nilgiri blue robin), nectariniid (black-throated sunbird, copper-throated sunbird, southern double-collared sunbird, Mrs Gould's sunbird, little spiderhunter, streaked spiderhunter, long-billed spiderhunter), oriolid (black-naped oriole, black-hooded oriole), pachycephalid (grey shrikethrush, olive whistler), panurid (bearded reedling, bearded reedling), paramythiid (tit	skin	Eurasia, Australasia, Africa, Americas

	berrypecker, eastern crested berrypicker), parulid (ovenbird, American redstart), passerid (house sparrow, russet sparrow, yellow-throated sparrow), passerellid (green-tailed towhee, dark-eyed junco, white-crowned sparrow, Harris's sparrow), pellorneid (Abbott's babbler), petroicid (South Island robin, dusky robin), ploceid (Baya weaver), piprid (lance-tailed manakin), prunellid (dunnock), pycnonotid (brown-eared bulbul, sooty-headed bulbul, common bulbul, Ayeyarwady bulbul, red-vented bulbul, stripe-throated bulbul, yellow-vented bulbul, Himalayan bulbul, light-vented bulbul, Styan's bulbul, white-spectacled bulbul, crested finchbill), remizid (Eurasian penduline tit), rhinocryptid (unicolored tapaculo), sittid (Eurasian nuthatch), sturnid (common myna, bank myna, common hill myna, Indian pied myna, common starling, black-collared starling, Brahminy starling, rosy starling, Daurian starling, metallic starling, Micronesian starling, Asian glossy starling, long-tailed glossy starling, Pohnpei starling, wattled starling, greater blue-eared starling, Cape starling, Madagascar starling, slender-billed starling, grosbeak starling, coleto), sylviid (tawny-flanked prinia), thraupid (blue-and-yellow tanager), tichodromid (wallcreeper), timaliid (chestnut-capped babbler), turdid (black-breasted thrush, wood thrush, western bluebird, white-necked thrush, creamy-bellied thrush, Japanese thrush, brown-headed thrush, black-breasted thrush, Austral thrush, clay-coloured thrush, common blackbird, American robin, eyebrowed thrush, song thrush, fieldfare, mountain thrush, red-throated thrush, mistle thrush, scaly thrush, Siberian thrush), zosteropid (warbling white-eye, silvereye); Piciformes: capitonid (lemon-throated barbet), lybiid (white-headed barbet, black-breasted barbet, black-collared barbet), picid (common flameback, downy woodpecker, white-wedged piculet, arrowhead piculet)		
M. exilis	Passeriformes: turdid (wheatear)	skin	Eurasia
M. exsanguis	Piciformes: picid (cream-backed woodpecker, crimson-crested woodpecker)	skin	South America
M. extraneus	Piciformes: picid (red-necked woodpecker)	skin	South America
M. falcatus	Galliformes: phasianid (marbled wood quail)	skin	South America
M. fasciatus	Galliformes: cracid (red-faced guan)	skin	South America
M. fertilis (syn. *M. upupae*)	Coraciiformes: upupid (hoopoe)	skin	Eurasia, Africa
M. genitalis	Galliformes: cracid (crested guan)	skin	Americas
M. geothlypis	Passeriformes: parulid (common yellowthroat, Connecticut warbler, MacGillivray's warbler)	skin	North America
M. gonophaeus (syn. *M. corvus, laticeps, masudi, ovatus*)	Passeriformes: corvid (house crow, pied crow, little crow, large-billed crow, Cape crow, common raven, little raven, forest raven, Australian raven, Chihuahuan raven, rook, western jackdaw, red-billed chough)	skin	Africa, Eurasia, North America
M. hilensis	Passeriformes: drepanidid ('i'iwi)	skin	Hawaii
M. infumatus	Coraciiformes: alcedinid (kookaburra)	skin	Australia
M. kaddoui	Galliformes: phasianid (peafowl)	skin	South Asia
M. kalatitar	Galliformes: phasianid (black francolin)	skin	India
M. laticephalus	Tinamiformes: tinamid (great tinamou)	skin	Central and South America
M. latus	Galliformes: cracid (black guan)	skin	Central America
M. leistidis	Passeriformes: icterid (white-browed meadowlark)	skin	South America
M. longipalpis	Galliformes: phasianid (kalij pheasant)	skin	Himalayas
M. longispinus	Galliformes: phasianid (spot-winged wood quail)	skin	South America
M. lyali	Galliformes: phasianid (red-legged partridge)	skin	Europe
M. machadoi	Cuculiformes: musophagid (blue turaco)	skin	Africa
M. mamola	Passeriformes: turdid (spotted forktail)	skin	Indochina
M. menura	Passeriformes: menurid (superb lyrebird)	skin	Australia
M. meridionalis	Galliformes: phasianid (spot-winged wood quail, marbled	skin	Central and South

	wood quail, black-breasted wood quail)		America
M. merisuoi	Passeriformes: corvid (house crow, grey treepie, spotted nutcracker, yellow-billed blue magpie)	skin	Eurasia
M. mikadokiji	Galliformes: phasianid (Mikado pheasant)	skin	Taiwan
M. mituensis	Galliformes: cracid (razor-billed curassow)	skin	Brazil
M. montagnii	Galliformes: cracid (Andean guan)	skin	South America
M. nelsoni	Passeriformes: artamid (dusky wood swallow)	skin	Australia
M. nogoma (syn. *M. orientalis*)	Passeriformes: motacillid (white wagtail), muscicapid (white-tailed robin, Siberian rubythroat, collared bush robin, golden bush robin, red-flanked bluetail)	skin	Indochina, Eurasia
M. nothoproctae	Tinamiformes: tinamid (brushland tinamou, curve-billed tinamou, Andean tinamou, Chilean tinamou)	skin	South America
M. numidae	Galliformes: phasianid (helmeted guineafowl)	skin	Africa
M. obsoleti	Passeriformes: troglodytid (rock wren)	skin	Americas
M. orioli	Passeriformes: malaconotid (black-backed puffback), oriolid (black-naped oriole, Eurasian golden oriole), pycnonotid (brown-cheeked bulbul, ochraceous bulbul, puff-throated bulbul, yellow-bellied bulbul, Asian red-eyed bulbul, stripe-throated bulbul, yellow-vented bulbul, black-capped bulbul)	skin	Asia, Africa
M. ortalidis	Galliformes: cracid (chestnut-winged chachalaca)	skin	Central America
M. pallidulus	Galliformes: phasianid (bamboo partridge, grey junglefowl, red junglefowl)	skin	Indochina
M. pallipes	Galliformes: phasianid (king quail)	skin	Asia, Oceania
M. pauxensis	Galliformes: cracid (helmeted curassow)	skin	South America
M. perijanus	Galliformes: phasianid (black-fronted wood quail)	skin	South America
M. phasiani	Galliformes: phasianid (common pheasant)	skin	Europe
M. pici (syn. *M. benii, bruneri, caquetae, ceophloeus, colaptis, dryobates, hoffmanni, koreae, picorum, pitius, praecursor, punensis*)	Piciformes: megalaimid (black-browed barbet, great barbet, brown-headed barbet), picid (northern flicker, Campo flicker, Chilean flicker, Andean flicker, green-barred woodpecker, lineated woodpecker, pileated woodpecker, golden-fronted woodpecker, red-bellied woodpecker, yellow-tufted woodpecker, red-headed woodpecker, acorn woodpecker, Hoffmann's woodpecker, grey-breasted woodpecker, Lewis's woodpecker, gila woodpecker, white-headed woodpecker, great spotted woodpecker, downy woodpecker, hairy woodpecker, grey-headed woodpecker, greater yellownape, European green woodpecker, yellow-bellied sapsucker)	skin	Americas, Europe, Indo-Asia
M. picicola	Piciformes: picid (black-backed woodpecker, Eurasian three-toed woodpecker)	skin	North America
M. pipilensis	Galliformes: cracid (piping guan)	skin	South America
M. pricei	Galliformes: phasianid (northern bobwhite)	skin	North America
M. pusillus (syn. *M. andalus, campestris, hispanicus, montanus, trivialis*)	Passeriformes: motacillid (tawny pipit, olive-backed pipit, Australasian pipit, meadow pipit, water pipit, tree pipit, African pied wagtail, white wagtail, western yellow wagtail)	skin	Eurasia, Africa, Australasia
M. quiscali	Passeriformes: icterid (rusty blackbird, brown-headed cowbird, boat-tailed grackle, great-tailed grackle, common grackle)	skin	North America
M. ralli	Gruiformes: rallid (water rail)	skin	Eurasia, Africa
M. robustus	Passeriformes: aegithalid (bushtit)	skin	North America
M. samaipatae	Galliformes: cracid (Spix's guan)	skin	South America
M. setifer	Galliformes: cracid (wattled guan)	skin	South America
M. sinuatus (syn. *M. bussei, minutus, subhorridus, subsimilis*)	Passeriformes: parid (coal tit, great tit, marsh tit, Eurasian blue tit, black-capped chickadee, mountain chickadee, chestnut-backed chickadee, tufted titmouse, whitethroat)	skin	North America, Eurasia
M. stramineus (syn. *M. biseriatus, meleagridis*) (yellow body louse, chicken body louse)	Galliformes: phasianid (chicken, kalij pheasant, ring-necked pheasant, turkey, helmeted guineafowl, Indian peafowl, satyr tragopan); Passeriformes: sturnid (common myna)	skin	worldwide
M. stubbei	Passeriformes: prunellid (brown accentor)	skin	Indochina

M. sturnellae	Passeriformes: bombycillid (cedar waxwing), sturnid (long-tailed meadowlark, eastern meadowlark, western meadowlark)	skin	Americas
M. takayamai (syn. *M. cettiae, obrteli*)	Passeriformes: cettid (Cetti's warbler, Japanese bush warbler), locustellid (Gray's grasshopper warbler, Middendorf's grasshopper warbler, lanceolated warbler, Savi's warbler), phylloscopid (Tickell's leaf warbler, dusky warbler)	skin	Japan
M. tarsatus (syn. *M. okadai*)	Galliformes: phasianid (crested partridge, crested wood partridge)	skin	Southeast Asia
M. tenuifrons	Passeriformes: troglodytid (marsh wren, sedge wren, Eurasian wren)	skin	Americas, Eurasia, Africa
M. tyranni	Passeriformes: tyrannid (grey kingbird, tropical kingbird, eastern kingbird, western kingbird, great kiskadee)	skin	Americas
M. unicolor	Galliformes: phasianid (black-backed partridge, chestnut-bellied partridge)	skin	Southeast Asia
M. valenciae	Galliformes: phasianid (Venezuelan wood quail)	skin	South America
M. werneri	Galliformes: phasianid (peacock-pheasant)	skin	Taiwan

***Holomenopon* species**	**Hosts**	**Location**	**Distribution**
H. acutae	Anseriformes: anatid (northern pintail, Cape teal)		Eurasia, North America
H. boehmi	Anseriformes: anatid (coscoroba swan)		South America
H. brevithoracicum	Anseriformes: anatid (kelp goose, upland goose, ruddy-headed goose, black-necked swan)		South America
H. bucephalae	Anseriformes: anatid (common goldeneye, bufflehead)		North America
H. cairinae	Anseriformes: anatid (Muscovy duck)		Americas
H. clauseni	Anseriformes: anatid (wood duck, blue-winged teal, bufflehead)		North America
H. clypeilargum	Anseriformes: anatid (northern pintail, American wigeon, Eurasian wigeon, northern shoveler, Eurasian teal, cinnamon teal, blue-winged teal, yellow-billed teal, garganey, American black duck, yellow-billed duck, ring-necked duck, greater scaup, New Zealand scaup, canvasback, gadwall, hooded merganser, common merganser)		cosmopolitan
H. goliath	Anseriformes: anatid (magpie goose)		Australasia
H. leucoxanthum (syn. *H. albofasciatum, concii, dendrocygni, hansloehrli, lunarium, nyrocae*) (shaft louse)	Anseriformes: anatid (mallard, Muscovy duck, long-tailed duck, common shelduck, Radjah shelduck, knob-billed duck, Pacific black duck, Indian spot-billed duck, ring-necked duck, ruddy duck, white-faced whistling duck, wandering whistling duck, fulvous whistling duck, plumed whistling duck, lesser whistling duck, tufted duck, gadwall, common pochard, southern pochard, red-crested pochard, common scoter, northern pintail, Eurasian wigeon, American wigeon, cinnamon teal, Sunda teal, Eurasian teal, Auckland teal, northern shoveler, greater scaup, lesser scaup, canvasback, redhead, hardhead, bufflehead, greylag goose, common pygmy goose, Canada goose, black swan): Suliformes: phalacrocoracid (cormorant)	skin, feathers	worldwide
H. loomisii	Anseriformes: anatid (velvet scoter, red-breasted merganser, common eider, king eider)		Eurasia, North America
H. maxbeieri	Anseriformes: anatid (mallard, black duck)		cosmopolitan
H. obscurum	Anseriformes: anatid (Radjah shelduck)		Australasia
H. setigerum	Anseriformes: anatid (northern pintail, northern shoveler, Cape shoveler, Eurasian teal, cinnamon teal, blue-winged teal, garganey, gadwall, white-winged duck, Australian wood duck, maned goose)		Americas, Eurasia, Australasia
H. tadornae (syn. *H. boetticheri, eulasium, museigottingense*)	Anseriformes: anatid (Egyptian goose, Andean goose, brant, ruddy shelduck, common shelduck, Australian shelduck, paradise shelduck); Suliformes: phalacrocoracid (reed cormorant)		Africa, Americas, Australasia, Indochina
H. transvaalense	Anseriformes: anatid (mallard)		South Africa
H. tumidum (syn. *H. africanum*)	Anseriformes: anatid (spur-winged goose)		Africa

Parasite morphology: Menoponid lice form 3 different type of morphological stages during their development: eggs (nits); nymphs (3 instars); and adults. Eggs are oval-elliptical in shape measuring from 0.8-0.9 x 0.4-0.5 mm and attached to feathers or other eggs by several rows of anterior attachment structures with hooked processes (soft and pliable when freshly laid but then drying and hardening thus separating adjacent eggs and keeping their anterior ends free of obstructions). The eggs are operculate and have an anterior dome-shaped cap formed by 8-10 structures fused together. The posterior (anopercular) end of the egg bears an egg-stigma (group of canals which partly or completely traverse the chorion) which assist in egg attachment. The eggs are embryonated and hatch to release first-stage nymphs (N1) which feed and moult through another 2 nymphal stages (N2, N3) before forming adults. All nymphs are similar in structure to adults, but are smaller (ranging from 1.2-1.8 mm in length), less sclerotized, have fewer body setae and lack genitalia. Adult lice are elongate and dorso-ventrally flattened measuring from 1.4-4.0 mm in length (*Holomenopon* 1.4-2.0 mm, *Menopon* 1.6-2.5 mm, *Menacanthus* 1.9-4.0 mm). Adults are often pale yellow in colour and have 3 distinct body parts (short broad head, small oval thorax, and elongate elliptical abdomen). The head is broadly triangular (almost as wide as body) with a prominent parabolic-rounded anterior margin and posterolateral bulges often bearing pairs of backwards directed spines. The head also bears a pair of compound eyes behind which are clavate (club-shaped) antennae (each composed of 4 segments) concealed in deep fossae (grooves). The ventral mouthparts consist of large opposing sclerotized mandibles used to shear or scrape host materials delivering food particles to the preoral cavity via a posterior plate-like labrum (often with an anterior hyaline pad-like protrusion (pulvinus)), lateral maxillae and an anterior labium with salivary secretions added through a central hypopharynx. In amblyceran lice, the mandibles lie parallel to the ventral surface of the head (such that the condyles are ventral and the ginglymus is dorsal), the maxillae and labium are reduced in size (compared to sucking lice) with single-lobed maxillae attached to the sides of the tripartite labium. Amblyceran lice also possess maxillary palps, each composed of 4 segments (palps absent in ischnoceran lice). The alimentary tract consists of a foregut (with pharynx, oesophagus and crop (expansion of oesophagus)), a large midgut (with ventriculus and anterior caeca) and a hindgut (with pylorus, papillae and rectum). Amblyceran chewing lice appear to lack a midgut mycetome (bacteriome or stomach disc) harbouring endosymbiotic microbes, although proteobacteria occur in the gut (mycetome well developed in anopluran sucking lice and less developed in ischnoceran chewing lice). The thorax is bipartite with a large anterior prothorax (oval in *Menacanthus*, semicircular in *Menopon* and *Holomenopon*) and a narrow mesothorax completely fused with the metathorax. The ventral thorax bears 3 pairs of legs, each comprising 5 segments (coxa, trochanter, femur, tibia, tarsus) and all ending in paired claws. The fore-legs are usually smaller than the mid- and hind-legs, and all legs usually have small groups of fine hairs. The abdomen is elongate, oval-elliptical in shape and often appears to have transverse bands or lateral patches of pigmented material. The abdomen is composed of 10 segments which are densely setate, with transverse rows of short-medium hairs and several long lateral bristles. Spiracles (openings to the tracheal (breathing) system) are visible at the dorsal edges of the abdominal segments. Adult lice exhibit sexual size dimorphism, with female lice being larger than males. The size differences between sexes of different menoponid species has been shown to generally conform to Rensch's rule (allometric increase in male body size relative to female size, i.e. larger lice produce bigger males although they remain smaller than females). Adult male lice have 3 pairs of testes (cf. 2 pairs in ischnoceran lice) with tubular vas deferens joining to form a seminal vesicle connected to the genital sac which is equipped with a tubular intromittent organ (aedeagus with dorsal gonopore and terminal endophallus) supported by a basal plate-like apodeme and 2 lateral rod-like parameres. Adult female lice have ovaries with polytrophic ovarioles connected via oviducts to a globular uterus with accessory glands (glue production), spermatheca (sperm storage) and a vaginal opening with a genital plate and valvula. Female lice do not have ovipositors but the terminal abdominal segment often has bifurcated apical lobes (gonopods) often bearing setae that aid in egg deposition.

Site of infection: These chewing lice are ectoparasitic on the feathers and skin of avian hosts, most parasite species being stenoxenous, that is, specific for closely-related host species (such as galliforms, anseriforms, passeriforms). Nymphs and adult lice usually live on the skin in the fluffy underlayer of the plumage and female lice attach their eggs around the bases of feathers. Menoponid amblyceran lice are less specialized than philopterid ischnoceran lice and may be found widely distributed over the body, although feeding and oviposition may be restricted to certain areas. *Menacanthus* spp. are found on the skin mostly in sparsely-feathered areas such as the vent, breast or thigh, but they may be more widespread in heavy infestations. *Menopon* spp. are most often seen resting in single files along shafts of breast and thigh feathers, but will disperse to the skin when disturbed. *Holomenopon* spp. are found on the skin and feathers of their anseriform hosts.

Pathogenesis: Light-mild infestations may be asymptomatic or remain subclinical, but heavier infestations may produce clinical disease, with morbidity (skin inflammation, irritation, hyperkeratosis, pruritus, plumage damage, scabs, anaemia, poor growth) and mortalities. Nymphs and adult lice use their modified mandibles to scrape and gnaw at the epidermis and bases of feathers, often penetrating to blood vessels to feed on blood. Infested birds may develop patches of skin with sloughing epithelial cells, small blood clots, oozing tissue exudates and scabs. Several *Menacanthus* spp. are particularly pathogenic in domestic poultry and some aviary birds (especially canaries), while many *Menopon* and *Holomenopon* spp. may cause plumage damage in fledged birds. Infested animals become restless and endeavour to relieve the pruritus by grooming (preening, scratching, rubbing) resulting in wet damaged plumage, unsightly appearance, feather loss (esp. *Menacanthus*), impaired thermoregulation, self-trauma, scabs (esp. *Menopon*), sometimes lameness and secondary infections, and reduced productivity (poor growth, weight loss, reduced egg production). Infestations are often worse on young birds, presumably due to their immature immune systems, poor grooming skills and

gregarious behaviours, although most *Menopon* spp. do not bother chicks until they are fully feathered, and menoponid lice are quite agile (compared to philopterid lice) and are better able to escape preening.

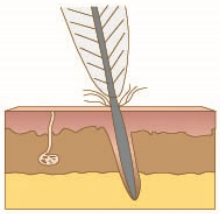
Several reports have implicated other amblyceran chewing lice (notably *Trinoton*) as potential vectors for filarial nematodes (*Sarconema*) of wild waterfowl (swans and geese). There have also been a few suggestions that *Menopon gallinae* may act as a reservoir, and possible vector, for fowl cholera, typhoid and toxoplasmosis, and recent molecular studies have detected *Toxoplasma* DNA in *Menacanthus stramineus* from chickens.

Developmental cycle and mode of transmission: The entire life-cycle of these chewing lice may occur on the skin and plumage of individual birds, with a generation time of 13-14 days. Transmission between hosts occurs when motile stages (nymphs, adults) are dislodged and move to new birds in direct or close contact. Female lice lay 1-4 eggs each day gluing them in clusters around the bases of feathers. The eggs hatch after 4–5 days releasing first-stage nymphs which begin feeding. The lice undergo hemimetabolous development with gradual (incomplete) metamorphosis through another 2 nymphal instars lasting around 3 days each before moulting to adults. After feeding and mating, female lice produce eggs for up to 12 days with peak egg production occurring after 5-6 days. None of the developmental stages are free-living and do not survive for long when dislodged from the host, usually dying within hours (sometimes days). Direct transmission takes place when lice crawl onto new hosts in close proximity, often when birds are crowded together (particularly when breeding, nesting, or huddling for warmth). Amblyceran menoponid lice are more active and agile than ischnoceran philopterid lice and infestations may spread rapidly through a flock. Infestations often exhibit seasonal variation, with lice being more prevalent and abundant in autumn and winter. Some studies have reported an apparent synchronization between host and louse reproduction, with louse numbers escalating when host breed, thus allowing parasites to disperse from one generation to the next.

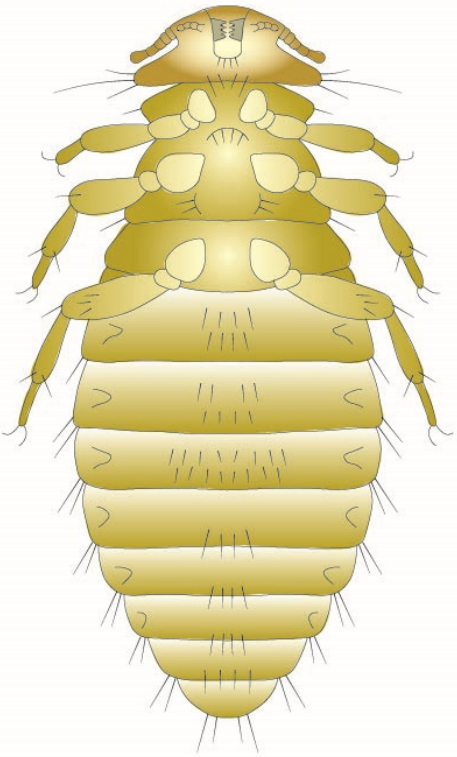
Differential diagnosis: Clinical infestations may be indicated by symptomatology, when birds exhibit restlessness, inflammation, irritation, pruritus, constant self-grooming and skin lesions with numerous small scabs and oozing exudates. Motile stages (nymphs, adults) may be detected moving around the skin and under plumage, although they rapidly scurry away from light when the feathers are parted. Louse eggs may be evident as pearl-coloured fans or masses at the bases of feathers. Louse developmental stages may be captured by hand or using forceps for subsequent microscopic examination and identification. Modern molecular biological techniques have been used to characterize some species and infer phylogenetic relationships following the polymerase chain reaction (PCR) amplification of parasite gene sequences, notably mitochondrial cytochrome oxidase I.

Treatment and control: Birds infested with chewing lice may be treated effectively using a range of insecticides, including organophosphates (malathion, tetrachlorvinphos), pyrethroids (permethrin), spinosyns (spinosad), macrocyclic lactones (ivermectin, moxidectin) and some natural products (such as rotenone (recently banned in several countries). However, louse eggs are often impervious to these chemicals so treatment needs to be repeated after 1-2 weeks to kill any emergent nymphs before they mature to adults and lay eggs. The whole flock should be treated at once and careful attention should be paid to regulations governing chemical usage in production animals (including with-holding periods, residues, contra-indications, environmental toxicity). Chemicals are available as topical applications (powders, sprays, baths) or as systemic formulations (injectable, oral or spot-on). Small numbers of birds are often treated using insecticidal powders or spray solutions ensuring thorough coverage by manually ruffling the plumage, rubbing the powder into the skin or mixing it with vaseline and applying to affected areas. Powders may also be scattered on litter or mixed with diatomaceous earth, sulphur dust, sand or wood ash and made available for self-administration in dust boxes in open aviaries, but not all bird species avail themselves of dust baths, nor do all individuals of compliant species. Liquid sprays, washes and baths have exhibited variable efficacy as feathers often provide waterproof barriers, and wet chilled birds may develop respiratory conditions. More recently, a range of liquids containing essential oil extracts were reported to have some efficacy, but some caused skin, eye or respiratory irritation, and many apparently acted only as repellents and birds quickly became re-infested. Several macrocyclic lactones have been used for the systemic treatment of infestations, with better residual activity providing longer term protection, but they are not registered for use in poultry destined for human consumption (including both meat and egg production). The prevention of infestations in farmed or aviary birds is based around providing clean facilities (washing or chemically treating cages, feeding and watering equipment), minimizing contact with infested individuals (through the isolation of infested individuals, the quarantine of new livestock, the exclusion of wild birds, avoiding over-crowding), maintaining healthy well-nourished birds (better able to resist clinical infestations) and ensuring they can preen (infestations worse in de-beaked birds).

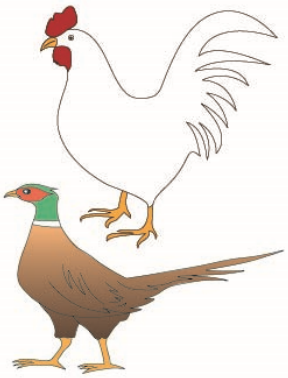
Menopon



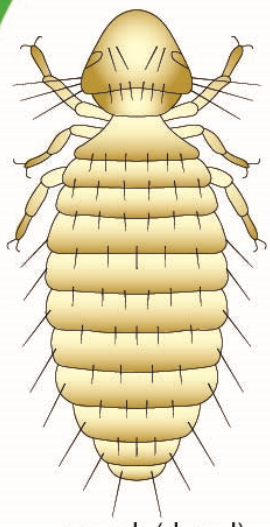
skin/plumage
(irritation, inflammation,
damaged feathers,
reduced productivity)



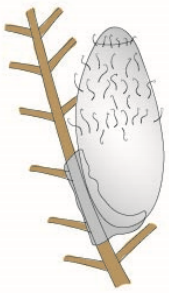
adult (ventral)
(~ 2 mm)



Definitive Hosts
(birds)



nymph (dorsal)
(~ 1.5 mm)

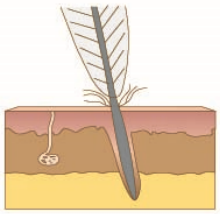


egg
(~ 0.9 mm)

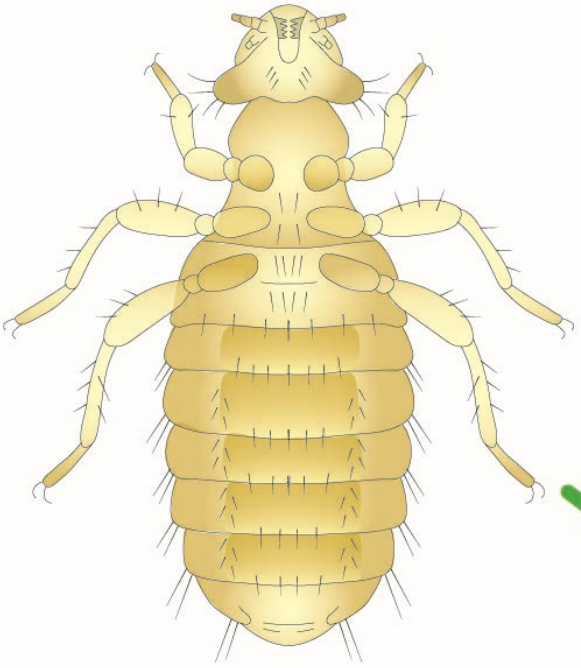
all stages ectozoic on host
(motile stages feed on skin/feathers)

transmission between hosts
through transfer of motile stages
by direct contact or via fomites

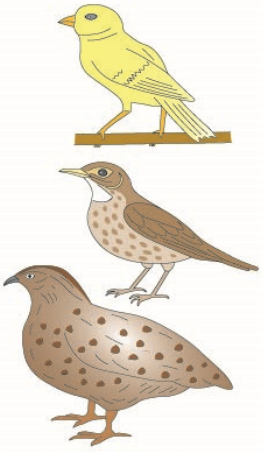
Menacanthus



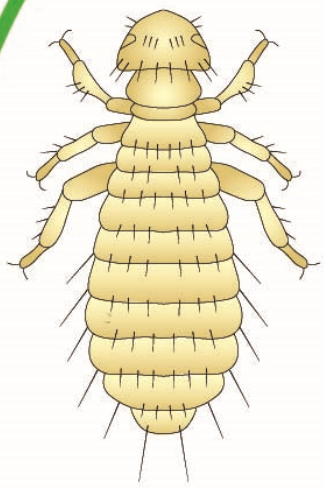
skin/plumage
(irritation, inflammation,
damaged feathers,
reduced productivity)



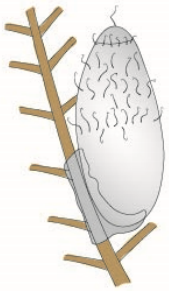
adult (ventral)
(~ 2 mm)



Definitive Hosts
(birds)



nymph (dorsal)
(~ 1.5 mm)

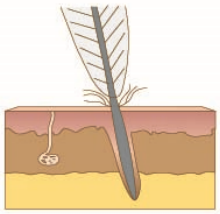


egg
(~ 0.9 mm)

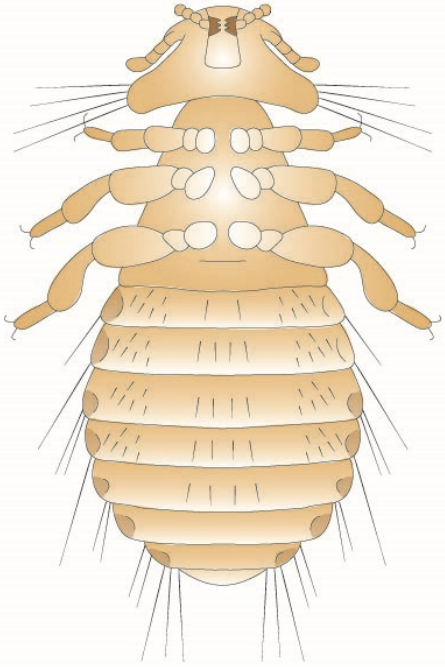
all stages ectozoic on host
(motile stages feed on skin/feathers)

transmission between hosts
through transfer of motile stages
by direct contact or via fomites

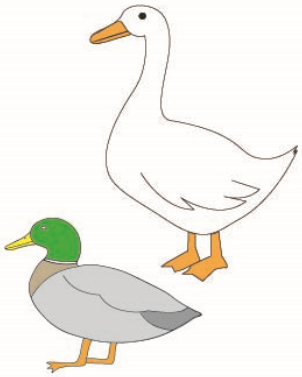
Holomenopon



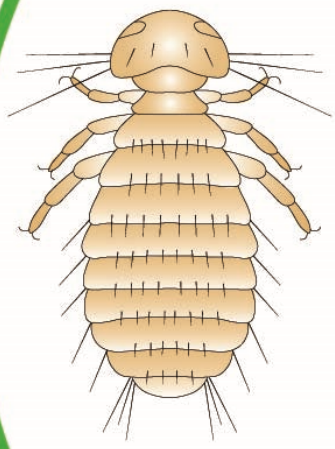
skin/plumage
(irritation, inflammation,
damaged feathers,
reduced productivity)



adult (ventral)
(~ 2 mm)



Definitive Hosts
(birds)

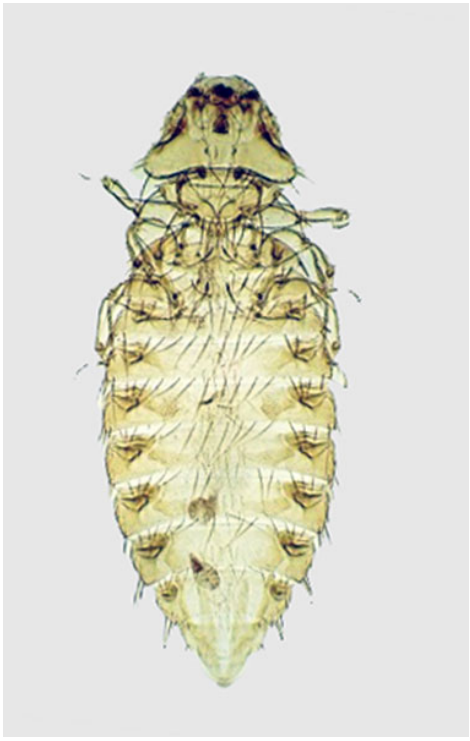


nymph (dorsal)
(~ 1.5 mm)

egg
(~ 0.9 mm)

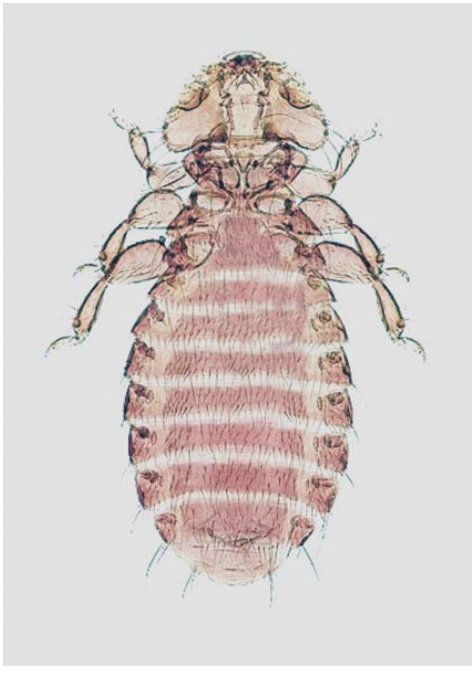
all stages ectozoic on host
(motile stages feed on skin/feathers)

transmission between hosts
through transfer of motile stages
by direct contact or via fomites

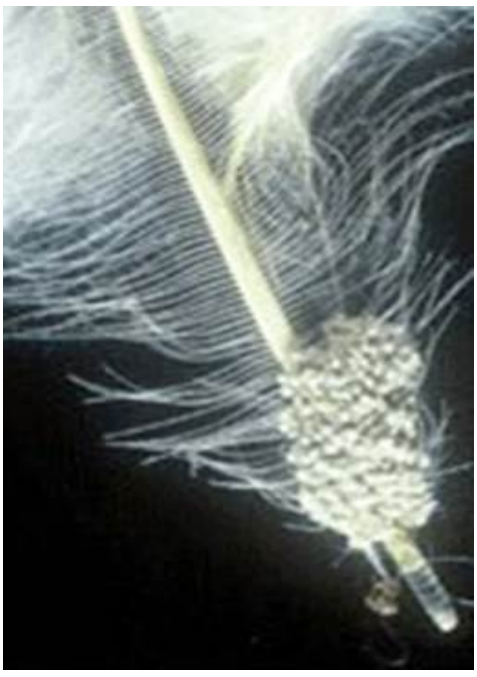


Menopon adult

Menacanthus adult



Holomenopon adult



Menopon eggs