

PSYCHE

VOL. XXXVII

DECEMBER, 1930

No. 4

NOTES ON HIPPOBOSCIDAE

2. THE SUBFAMILY HIPPOBOSCINAE

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Although much has been written concerning some of the common species of *Hippobosca* that infest equines and cattle, no comprehensive and critical account of the genus as a whole has been published thus far. The present attempt at filling this gap cannot be more than preliminary, especially with regard to the synonymy adopted for the many names proposed in this group. In no case have I had access to the types on which these names were based.

The genus *Hippobosca* occupies an isolated position in the family Hippoboscidae, forming a subfamily of its own, which was first defined by Speiser (1908, *Zeitschr. Wiss. Insektenbiol.*, IV, p. 445).

Subfamily **Hippoboscinae**

Head rounded posteriorly, entirely free from the anterior margin of the thorax. Antennal pits completely enclosed by a continuous rim, containing the small, subglobular antennae, which have no dorsal prolongation. No ocelli. Pronotum well developed dorsally, visible between the head and the mesonotum. Humeral angles rounded off, not projecting. Claws simple, but apparently bidentate, without supplementary tooth between the sharp apex and the

broad, flattened "heel" of the base. Wings always well developed and functional throughout adult life; six distinct longitudinal veins and a vestigial seventh vein between the fifth (M_{3+Cu_1}) and sixth (An); two cross-veins, the anterior (r-m) and the anterior basal (m-cu or M_3); second basal cell very long; no closed anal cell; membrane bare, but rilled with numerous delicate, more or less parallel wrinkles, extending from the region of distinct veins toward the hind margin.

The subfamily contains only one genus.

Hippobosca Linnæus

Hippobosca Linnæus, 1758, "Syst. Nat.," 10th Ed., I, p. 607 (type: *Hippobosca equina* Linnæus, 1758, designated by Latreille, 1810, Considér. Génér. Crust. Arachn. Ins., pp. 407 and 444).

Hippobosca subgenus *Nirmomyia* Nitzsch, 1818, in Germar's Mag. d. Entom., III, p. 309 (monotypic for *Hippobosca equina* Linnæus, 1758).

Zoomyia Bigot, 1885, Ann. Soc. Ent. France, (6) V, pp. 227 and 234 (tentatively proposed as a substitute for *Hippobosca*; type by present designation: *Hippobosca equina* Linnæus, 1758).

Attention may be called to the remarkable structure of the pulvilli and empodium, which in this genus offer excellent specific characters.

The genus *Hippobosca* is indigenous throughout the continental areas of the Old World. All of the eight species, which I recognize as valid, are found in Africa; four of them extend also into the Oriental Region and two have entered Europe. Much of the present distribution of *H. equina*, *H. camelina*, *H. maculata*, and *H. capensis* is undoubtedly artificial and due to the spreading of their domestic hosts by man. I have tried to trace the probable original home of these species, but the conclusions I have reached

are far from satisfactory.¹ None of the species appear to have become naturalized in the New World, where their occurrence is very accidental.

With one exception, the species of Hippobosca are ectoparasites of mammals, mainly of Ungulates and Carnivora. *H. struthionis*, however, is a normal parasite of the ostrich. Since the Ungulates and Carnivora were more numerous and more widely distributed in Mesozoic times than nowadays, it is safe to assume that Hippobosca has had a long geological past and may have been at one time cosmopolitan. The few living species are perhaps only the remnants of a large group of parasitic flies, which may have been as numerous in species as the living Hippoboscidae of birds.

The Hippoboscæ are fairly good fliers. The gravid female leaves the host and deposits the full-grown larva in cracks of walls, in holes of trees, or on the ground. Patton, for instance, observed a female of *H. capensis* leave a dog, fly onto a wall and, after running along it, rapidly disappear into a crack. The fly remained there a few minutes; as it emerged, it was caught, and, on examining the crack, a larva was found a little distance inside (Patton and Evans, 1929, "Insects, Ticks, etc., of Medical and Veterinary Importance," I, p. 404).²

Host specificity is not very pronounced among the Hippoboscidae which retain the wings throughout adult life, and this statement applies particularly to Hippobosca. Only the species of the ostrich seems to be restricted to a single host-species. *H. fulva*, *H. hirsuta* and *H. camelina* also have a narrow range of normal hosts. The other species have nowadays a variety of usual hosts; but in some cases this may be an artificial condition, due to the influence of man. Spreading of certain species by man beyond their

¹ There is a voluminous literature dealing with the ancestors of domestic animals. After consulting a number of publications, I have found what appears to be the most reliable information in Keller, Conrad, 1902. "Die Abstammung der ältesten Haustiere," (Zurich), 232 pp.

² I have not found any evidence that the puparia of Hippobosca are ever placed among the fur or feathers of the host, as Theobald (1906, 2d Rept. Wellcome Res. Lab. Khartoum, p. 92) has claimed.

original home may perhaps explain partly why more than one species of *Hippobosca* infest nowadays domestic equines and cattle. I have attempted to distinguish in a table between the "normal" and the "facultative" or "accidental" hosts, in so far as feasible.

	Normal Hosts	Facultative and Accidental (Acc.) Hosts
<i>H. equina</i>	domestic equines	cattle (Acc.: dog, rabbit, camel, birds)
<i>H. capensis</i>	domestic dog, lion, leopard, h y e n a , cheetah, civet, fox, serval	duiker, dik-dik (Acc.: mule)
<i>H. fulva</i>	hartebeest	
<i>H. maculata</i>	domestic equines and cattle	camel, dromedary
<i>H. rufipes</i>	domestic equines	domestic cattle, wildebeest, eland, giraffe (Acc.: ? ostrich)
<i>H. hirsuta</i>	waterbuck and al- lied antelopes	
<i>H. struthionis</i>	ostrich	
<i>H. camelina</i>	camel, dromedary	horse (? Acc.)

The following alphabetical list of 36 names will serve as an index to the synonymy here adopted:

albo-maculata Macquart=*rufipes* v. Olfers.

albonotata Rondani=*rufipes* v. Olfers.

bactriana Rondani=*camelina* Leach.

bengalensis Ormerod=*maculata* Leach.

bipartita Macquart=*maculata* Leach.

calopsis Bigot=*maculata* Leach.

cameli Leach=*camelina* Leach.

8. *camelina* Leach. A valid species.

camelopardalis Roubaud=*rufipes* v. Olfers.

canina Rondani=*capensis* v. Olfers.

2. *capensis* v. Olfers. A valid species.
chinensis Giglioli=*capensis* v. Olfers.
cunicosa Thalhammer=*capensis* v. Olfers.
dromedarina Speiser=*camelina* Leach.
egyptiaca Macquart=*maculata* Leach.
equi Macquart=*equina* Linnæus.
1. *equina* Linnæus. A valid species.
fossulata Macquart=*maculata* Leach.
francilloni Leach=*capensis* v. Olfers.
3. *fulva* Austen. A valid species.
6. *hirsuta* Austen. A valid species.
laticornis Macquart=*capensis* v. Olfers.
longipennis Fabricius=probably *capensis* v. Olfers.
4. *maculata* Leach. A valid species.
maculata Macquart=*rufipes* v. Olfers.
marginata v. d. Wulp=*rufipes* v. Olfers.
massaica Speiser=*struthionis* Janson.
neavei Austen=*hirsuta* Austen.
orientalis Macquart=*capensis* v. Olfers.
5. *rufipes* v. Olfers. A valid species.
sivæ Bigot=*maculata* Leach.
7. *struthionis* Janson. A valid species.
sudanica Bigot=*maculata* Leach.
taurina Rondani=*equina* Linnæus.
variegata Wiedemann=*maculata* Leach.
wahlenbergiana Jænnicke=*rufipes* v. Olfers.

KEY TO SPECIES OF HIPPOBOSCA

I have studied specimens of the seven valid species separated by the subjoined key, which I have attempted to base mainly upon reliable structural characters. I have found that the coloration, although often helpful, is rather variable in certain species, and I do not regard it as of specific value when no differences in structure can be discovered.

Hippobosca fulva Austen appears to be distinct from the other seven. I have not seen it, and the characters given in the description do not allow of its being included in my key.

1. Second longitudinal vein (R_{2+3}) long, reaching the costa much beyond the tip of the first longitudinal (R_1) and apicad of the anterior cross-vein; the last section of the costa at most three times the length of the penultimate section. Base of third longitudinal vein (R_{4+5}) bare. One pair of vertical bristles. Two pad-like pulvilli at the sides of the bristle-like empodium, one much larger than the other..... 2
 Second longitudinal vein short, reaching the costa together with or close to the tip of the first longitudinal; the last section of the costa equal to at least five times the distance between the tip of the first and that of the second longitudinal veins 3
2. Apical lobes of the fronto-clypeus regularly and sharply triangular, their inner margins nearly straight. Scutellum as a rule wholly ivory-white; wing veins mostly pale testaceous, with some darker stretches. Smaller, the wing 5 to 6 mm. long.....*H. capensis*
 Apical lobes of the fronto-clypeus irregularly and broadly triangular, their inner margins curved. Scutellum fuscous to ferruginous on the sides, yellowish white in center, rarely more extensively yellowish; wing veins as a rule rufous to dark brown. Larger, the wing 6 to 8.5 mm. long*H. equina*
3. Base of third longitudinal vein setulose over some length on the upper side. One pair of vertical bristles. Only one pulvillus well developed, the other rudimentary 4
 Base of third longitudinal vein bare 6
4. Second longitudinal vein very short, forming an oblique cross-vein which ends in the first longitudinal and runs from opposite or apicad of the upper tip of the anterior basal cross-vein to basad of the anterior cross-vein. Scutellum as a rule with three ivory-white spots, the largest in the center; bristles of head and thorax pale. Large, the wing 7 to 8 mm. long*H. maculata*
 Second longitudinal vein much longer and more oblique, ending in the costa close to or at the tip of the first longitudinal and running from basad of the upper tip of the anterior basal cross-vein to opposite or basad of the anterior cross-vein 5

5. Vertex distinctly narrower at the occiput than at the fronto-clypeus in both sexes. Scutellum very wide and nearly rectangular, with a median, rufous, and two lateral, ivory-white spots. Legs bright reddish; bristles of head and thorax brownish black. Larger, the wing 7 to 9 mm. long*H. rufipes*

Vertex about as wide at the occiput as at the fronto-clypeus. Scutellum narrower and less rectangular, with a median, ivory-white spot. Legs rufous-yellow; bristles of head and thorax pale. Smaller, the wing 6.5 to 8 mm. long*H. hirsuta*

6. Two pairs of vertical bristles. Sclerotized upper plate of vertex (or vertical triangle) about as long as wide at the occiput, much shorter than the medio-vertex, the latter considerably narrowed in the middle by the very broad inner orbital plates. Apical lobes of fronto-clypeus broadly separated by a semi-elliptical notch. Second longitudinal vein ending in the tip of the first, opposite the anterior cross-vein. Anterior basal cross-vein very oblique and nearly its own length from the anterior cross-vein. Scutellum semi-elliptical in outline, its posterior margin distinctly convex and slightly projecting in the middle. No pad-like pulvilli; the bristle-like empodium bare, except at the base. Larger, the wing 9 to 10 mm. long*H. camelina*

One pair of vertical bristles. Sclerotized upper plate of vertex longer than wide at the occiput, as a rule longer than the medio-vertex, the latter moderately narrowed by the inner orbital plates. Apical lobes of the fronto-clypeus separated by a narrow notch. Second longitudinal vein reaching the costa close to the tip of the first and apical of the anterior cross-vein. Anterior basal cross-vein short, almost vertical upon the fourth longitudinal and more than twice its own length from the anterior cross-vein. Scutellum subrectangular, broadly truncate at the apical margin, not projecting in the middle. Two pad-like pulvilli; the empodium feathered. Smaller, the wing 7 to 7.5 mm. long*H. struthionis*

1. *Hippobosca equina* Linnæus

Hippobosca equina Linnæus, 1758, "Syst. Nat.," 10th Ed., I, p. 607 (no sex given; Europe and North America). Austen, 1906, "Illustr. Brit. Blood-Suck. Flies," p. 63, Pl. XXXI. Newstead, Dutton and Todd, 1907, Ann. Trop. Med. Paras., I, p. 90, figs. 17 (♀) and 18 (puparium). Schuurmans-Stekhoven, 1926, Parasitology, XVIII, p. 49, Pl. IV, figs. 3 and 4 (♀ ♂).

Hippobosca equi Macquart, 1835, "Hist. Nat. Ins. Dipt.," II, p. 638, Pl. XXIV, fig. 8 (error for *H. equina*).

Hippobosca taurina Rondani, 1879, Boll. Soc. Ent. Italiana, XI, pp. 24 and 25 (no sex given; off cattle in central Italy).

SPECIMENS EXAMINED.—Sweden: (Ljungh). Germany: Berlin. Spain: Montanegos (Cevera); Escurial; Iviza, Balears (W. M. Wheeler). France: Banyuls-sur-Mer, Pyr. Or., off a dog (G. Dimmock). Sardinia: (Krausse). Turkey: Reshadie (H. R. Hagan). Egypt: (S. H. Scudder). New Caledonia: Plum Farm (T. D. A. Cockerell). Belgian Congo: Kitobola, two males, 1913 (Rovere). Philippines: Manila (M. J. Myers).

DISTRIBUTION.—This common species is known in England as the "forest-fly," after the New Forest in Hampshire, where it is particularly abundant. It may have been at first restricted to southern Europe and western Central Asia; but nowadays it is found throughout Europe (as far north as Lapland, and also in the British Isles), Northern Africa (as far south as Biskra), the Canary Islands, Madeira, the Azores, the Senegal, the Anglo-Egyptian Sudan, Egypt, Palestine, Asia Minor, India, the Sunda Islands, the Philippines, Celebes, Fiji, the New Hebrides and New Caledonia (introduced about 1890). It has been seen on freshly imported horses in Australia, but it does not seem to have become established there. Linnæus (1758) mentioned North America as part of the habitat and Loew [1864, Amer. Jl. Sci. Arts, (2) XXXVII, p. 318] included

it among the species of Diptera common to Europe and America. It is doubtful, however, whether either Linnaeus or Loew actually saw American specimens. Loew's record may have been based upon the earlier statement by W. Kirby (1837, *Fauna Boreali-Americana*, IV, p. 317; see Bethune, 1881, *Canad. Entom.*, XIII, p. 169), who listed *H. equina* among the insects of Boreal America, without, however, mentioning a definite locality. Notwithstanding certain discrepancies, Kirby's description seems to have been based upon a specimen of true *equina*; but whether or not it came from North America is open to question. In any case, no other entomologist seems to have reported this fly from a New World locality, and I have never seen an authentic American specimen in any collection. Moreover, it is somewhat of a mystery why this fly has not become established in America, since it must have been brought over repeatedly from the Old World.

Newstead, Dutton and Todd (1907) state that they saw a few examples of *H. equina* on cattle, shipped at Las Palmas, Canary Islands, while on board ship on their way to the Belgian Congo. But the two specimens which I have seen from Kitobola are the only ones actually taken in tropical Africa, where *H. equina* seems to be replaced by *H. maculata*. Walker (1849, "List Dipt. Brit. Mus.," IV, p. 1140) includes the Cape Colony in the range of the species, but no specimens have since been taken in South Africa.

HOSTS.—*H. equina* is usually found on equines (horses, mules and donkeys), sometimes also on cattle and more rarely on dogs, rabbits, or camels. Accidentally it may stray to birds. Massonat (1909, *Ann. Université Lyon*, N. S., CXXVIII, p. 242) saw specimens from owls (*Tyto flammea*) and from a kite (*Milvus regalis*), and Schuurmans-Stekhoven captured one on a pigeon. It is of interest that this species has never been taken on the wild equines of Africa.

The predilection which *H. equina* shows for horses makes it very probable that this insect was originally a specific parasite of one of the wild horses from which the domestic

racés have been derived. According to C. Keller (1902), the ancestor of the heavy races of horses was a wild equine which lived in Europe during the Pleistocene (*Equus caballus* Linnæus) and even survived until historic times. The lighter races, on the other hand, had an Asiatic origin and were most probably derived from *Equus przewalskii* Poliakov, a wild equine of Central Asia, of which a few specimens may be living yet in a feral state in Dzungaria. I am inclined to the view that both these ancestral species were infested with *H. equina*, although, of course, this is a mere hypothesis. It may yet be possible to find the insect on the living *E. przewalskii*.

AFFINITIES.—*H. equina* and *H. capensis* appear to be very closely allied, although there can be no doubt that they are specifically distinct. After a very careful study, I have found that the only structural difference, which seems to be entirely reliable, is found in the shape of the fronto-clypeus. I had thought at first that the wing venation afforded some additional distinctive features. The relative distance from the tip of the second longitudinal vein to that of the first and third longitudinals appears to be highly variable. The length of the anterior basal cross-vein (or second basal cross-vein; *m-cu* or *M₃*) is perhaps more reliable: in *H. capensis* this cross-vein is fairly straight and, as a rule, about as long as the distance from its tip to the anterior cross-vein (*r-m*); in *H. equina* it is more curved and generally much longer than the distance from its tip to the anterior cross-vein.

In one male of *H. equina*, from Sardinia, the left wing has a double anterior cross-vein, enclosing a small supernumerary cell; the right wing is normal.

A further specific character may perhaps be found in the size and shape of the sclerotized upper plate of the vertex (vertical triangle). In all the 29 specimens of *H. equina* examined, this plate occupies about the upper third of the vertex, being at most half the length of the medio-vertex (or frontalia); it is almost semi-circular in outline and much wider at the occiput than long on the middle line. In most of the specimens of *H. capensis* seen,

this upper vertical plate is much more extensive, being over half the length of the medio-vertex, sometimes occupying nearly half of the vertex; it is rather semi-elliptical and only a little wider at the occiput than long on the middle line. Unfortunately I have seen several specimens of *H. capensis* which in the shape of the vertex do not appreciably differ from *H. equina*. Nevertheless, this character may be of specific value, even though its variability prevents its being used in a key.

The color peculiarities of the scutellum and of the venation, which have been generally used as specific characters, I have found to be extremely variable and wholly unreliable in these two species. I have seen specimens of *H. equina* colored almost exactly like *H. capensis*, and I am certain that the two have often been confused in collections.

2. *Hippobosca capensis* v. Olfers

Hippobosca capensis v. Olfers, 1816, "De Vegetativis et Animatis Corporibus in Corpor. Anim. Reper. Comm.," I, p. 101 (not seen).

Hippobosca francilloni Leach, 1817, "Gen. Spec. Eprobosci. Ins.," p. 8, Pl. XXVI, figs. 8-10 (no sex given; without locality). Theobald, 1906, 2d Rept. Wellcome Res. Lab. Khartoum, p. 92, figs. 51 and 53C; Pl. X, fig. 1 (♀).

Hippobosca orientalis Macquart, 1842, Mém. Soc. Sci. Lille, p. 432, Pl. XXXVI, fig. 6; 1843, "Dipt. Exot.," II, 3, p. 275, Pl. XXXVI, fig. 6 [called *Hippobosca laticornis* in the Explanation of Plates, p. 294] (no sex given; East Indies).

Ornithomyia chinensis Giglioli, 1864, Quart. Jl. Micr. Sci., N. S., IV, p. 23, Pl. 1B, figs. 10 and 11 (no sex given; China; supposedly off *Turdus obscurus*).

Hippobosca canina Rondani, 1878, Ann. Mus. Civ. Genova, XII, p. 164 (no sex given; Italy, Southern Europe, Persia, South and East Africa).

Hippobosca cunicosa "Madarasz," Thalhammer, 1899, "Fauna Regni Hungarici, Diptera," p. 69 (without description).

Hippobosca longipennis Fabricius, 1805, "Syst. Antliat.," p. 338 (no sex given, Tranquebar), is probably also *H. capensis* v. Olfers. The very brief description is as follows: "H. alis obtusis corpore duplo longioribus, corpore ferrugineo immaculato. Minor *H. equina*. Caput et thorax ferruginea, immaculata. Abdomen brevissimum; segmento primo transverso, carinato. Alæ longissimæ, albæ. Forte mera *H. equina* varietas." Speiser (1904, Ann. Mus. Civ. Genova, XLI, p. 332) claims to have recognized this species in a specimen at the Genoa Museum, collected by Fea (1885) at Mandalay, Burma. He states that the wing venation is as in *H. equina*, but otherwise mentions only color characters. Later (1908, Zeitschr. Wiss. Insektenbiol., IV, pp. 301 and 443) Speiser regarded it as a typically Oriental species, differing from all others in the absence of pale markings. The only specimen he saw was about the size of *H. capensis* (wing 6.5 mm. long). I hesitate, however, to change the name of this well-known species until Fabricius' type can be critically studied.

SPECIMENS EXAMINED.—Tunis: Kairouan (F. Sant-schi). Egypt: Bab-el-Wadi, Assuan (Nasarey); Lower Egypt (Nasarey); Luxor (G. Allen), off *Vulpes vulpes egyptiaca* (Desmarest). Kenya Colony: Hills west of Mt. Kenya, off a spotted hyena, *Crocuta crocuta fisi* Heller, July 3, 1909 (G. M. Allen); Sabaki (L. Bayer); Campi Kiboko (L. Bayer); Kerio River (L. Bayer); Tsavo River (L. Bayer); Magadi Railway (C. M. Woodhouse). Tanganyika Territory: Saranda near Dodoma, off a serval, *Felis capensis hindei* Wroughton (A. Loveridge); Tabora, off a lion, *Felis leo* Linnæus (J. Rodhain); between Tabora and Kigoma (Stamper); 25 miles east of Ikoma, numerous specimens off a lion, and one male off a young leopard, *Felis pardus suahelicus* Neumann (J. P. Chapin); Dodoma, on man (A. Loveridge). Portuguese East Africa: Lourenço Marques (C. W. Howard). Japan: Kamagawa (J. T. Gulick). China: Wuchang (C. M. A. Wassell); Kao-Ghiao

(J. Hervé-Bazin); Suifu, Sze-Chuen (D. C. Graham); Soochow (N. Gist Gee); Nanking, off dogs (C. S. Low); Penniu (C. Y. Wong). India: Koolloo (M. M. Carleton). Tonkin.

DISTRIBUTION.—*H. capensis* is common in many parts of the Mediterranean Subregion (Italy, Sicily, Macedonia, Crimea, Asia Minor, Palestine, Cyprus, Egypt, Cyrenaica, Tunis, Algeria), throughout the Sudan (as far as Northern Nigeria), in East and South Africa (Eritrea, Kenya Colony, Tanganyika Territory, Zanzibar, Transvaal, Cape Province, Southwest Africa), Transcaspia, Turkestan, Persia, India, Ceylon, China, Korea, and Japan. It has also been found in Bukowina, Hungary and Poland; and there is one record from Germany (Berlin), where the insect was certainly an accidental introduction. It has never been reported from the Malay Archipelago, and it appears to be absent from the West African Subregion. There is, as yet, no record from within the boundaries of the Belgian Congo, although I should expect it to occur in Upper Katanga.

I have seen a specimen of *H. capensis*, from the Canadian National Collection, labelled Okanogan Falls, British Columbia, May 20, 1913 (E. M. Anderson), without indication of a host.

HOSTS.—*H. capensis* was most probably originally a parasite of wild Carnivora in East and South Africa and in the Oriental Region. There are positive records of its having been found in the wild state, in East Africa, on lion, *Felis leo* Linnæus; striped and spotted hyena, *Hyæna hyæna* (Linnæus) and *Crocuta crocuta* (Erxleben); leopard, *Felis pardus* Linnæus; cheetah, *Acinonyx jubatus* (Schreber); civet cat, *Civettictis civetta* (Schreber); serval, *Felis capensis* Forster; and fox, *Vulpes vulpes* (Linnæus). Unfortunately there appears to be no record from any of the Indian wild Carnivora. It is nowadays most commonly found on domestic dogs, especially on the pariah dogs of India, which are said to be fairly swarming with "louse-flies." It has also been taken occasionally on some of the smaller antelopes, such as the duiker, *Cephalophus grimmia*

(Linnæus) (according to A. Loveridge, 1923, Proc. Zool. Soc. London, p. 734), and the dikdik, *Rhynchotragus kirkii cavendishi* (Thomas) (according to Speiser, 1915, Ark. f. Zool., IX, No. 13, p. 3). Waterston (1918, Bull. Ent. Res., IX, p. 155) mentions having taken it on a mule. Very rarely it strays to man, but I have not found any evidence that it actually bites human beings. Giglioli's record of "*O. chinensis*" from a bird (*Turdus obscurus*) seems rather open to question. Speiser (1905, Zeitschr. Syst. Hym. Dipt., V, p. 349), who examined Giglioli's type, found that his *O. chinensis* was a *H. capensis*.

The innumerable races of domestic dogs are certainly of polyphyletic origin. C. Keller (1902) traces them to at least six wild species of jackals and wolves. The pariah dog of Northern Africa and Southern Asia he derives from the common jackal of those regions, *Canis aureus* Linnæus, which quite possibly may have been one of the original hosts of *H. capensis*, from which the insect passed onto the pariah dog.

AFFINITIES.—These have been discussed under *H. equina*.

3. *Hippobosca fulva* Austen

Hippobosca fulva Austen, 1912, Bull. Ent. Res., III, p. 417
[♀ ; off hartebeest, *Alcelaphus lichtensteini* (Peters) ;
Nawalia, Northeastern Rhodesia].

H. fulva is known only from the type-locality. To judge from Austen's description, it appears to be closely related to *H. capensis*, with which it agrees in size (wing 5 mm. long) and in the pale straw-yellow scutellum. The remainder of the thorax, however, is deep tawny and devoid of markings, while the veins of the wing are uniformly ochraceous. The main structural difference seems to be found in the venation: "third longitudinal vein straight and much closer to second longitudinal vein and costa than in case of *H. capensis* v. Olfers, so that the submarginal cell is conspicuously narrower than in the species mentioned."

4. *Hippobosca maculata* Leach

Hippobosca maculata Leach, 1817, "Gen. Spec. Eprobosci. Ins.," p. 7, Pl. XXVI, figs. 11-13 (no sex given; East Indies). Austen, 1909, "Illustr. African Blood-Suck. Flies," p. 173, Pl. XIII, fig. 99 (♀). Schuurmans-Stekhoven, 1926, Parasitology, XVIII, p. 36, figs. I-V; Pl. IV, figs. 1-2 (♀ ♂, larva, puparium and biology).

Hippobosca variegata Wiedemann, 1830, "Aussereurop. Zweifl. Ins.," II, p. 603 (no sex given; Bengal and Tranquebar).

Hippobosca bipartita Macquart, 1842, Mém. Soc. Sci. Lille, p. 432; 1843, "Dipt. Exot.," II, 3, p. 275 (no sex given; Pondichéry, India).

Hippobosca egyptiaca Macquart, 1842, Mém. Soc. Sci. Lille, p. 431, Pl. XXXVI, fig. 5; 1843, "Dipt. Exot.," II, 3, p. 274 (♂; Egypt) [also spelled *aegyptiaca*, p. 274; and *oegyptiaca*, in Explanation of Plates, p. 294].

Hippobosca fossulata Macquart, 1842, Mém. Soc. Sci. Lille, p. 433; 1843, "Dipt. Exot.," II, 3, p. 276 (no sex given; Brazil or Chile). Speiser, 1904, Ann. Mus. Civ. Genova, XLI, p. 333.

Hippobosca sudanica Bigot, 1884, Ann. Soc. Ent. France, (6) IV, Bull. Séances, p. lix (♀; off horses; eastern Sudan).

Hippobosca sivæ Bigot, 1885, Ann. Soc. Ent. France, (6) V, p. 235 (no sex given; East Indies).

Hippobosca calopsis Bigot, 1885, Ann. Soc. Ent. France, (6) V, p. 236 (no sex given; Ceylon).

Hippobosca aegyptiaca var. *bengalensis* Ormerod, 1895, The Veterinary Record (August); 1896, Indian Mus. Notes, IV, 2, p. 80 (no sex given; off horses; Bengal).

SPECIMENS EXAMINED.—Uganda: Turkana, Morongole, Northeastern district (Dr. H. Owen). Belgian Congo: Loka, off cattle, May 9, 1909 (Bovone). French West

Africa: Upper Volta River, off horse (E. Roubaud). Abyssinia: Darai, Harar Province (Barnum Brown). Zanzibar: (W. M. Aders). Portuguese East Africa: Lourenzo Marques (C. W. Howard). Mauritius (D. de Charmoy). Madagascar: Tananarive (Lamberton); Mandritsara (F. R. Wulsin). India: Sohawa, Shilum (H. E. Cross); Calcutta. Southern Arabia: Aden, common on oxen, May 9, 1927 (J. Bequaert). Philippines: Alabang (M. B. Mitzmain).

DISTRIBUTION.—*H. maculata* is at present found over a very large area, but much of this is undoubtedly due to accidental introduction by man. In the Oriental Region, it is known from Persia, India, Ceylon, the Sunda Islands, and the Philippines. It also occurs in Arabia. In Africa it is very widely distributed, although much more common in the eastern parts than in the West and the South. There are records from Egypt, the Anglo-Egyptian Sudan, Eritrea, Abyssinia, the French Sudan, Sierra Leone, French Guinea, the Gold Coast, Northern and Southern Nigeria, northern Cameroon, French Equatorial Africa, Uganda, the Belgian Congo, Kenya Colony, Somaliland, Zanzibar, Portuguese East Africa, Transvaal, Madagascar, Mauritius and the Seychelles. It has not been reported from northwestern Africa nor from south of the Orange River, so that it appears to be mainly a tropical insect.

HOSTS.—Nowadays *H. maculata* occurs most commonly on domestic cattle and equines (horses, donkeys and mules), sometimes also on camels. There are no reliable records of its having been found on wild animals. The specimens taken by Neave in the Luangwa Valley, Rhodesia, off a waterbuck, *Kobus ellipsiprymnus* Ogilby, and which he listed as *H. maculata* (1911, Bull. Ent. Res., I, 4, p. 313), were evidently part of the material on which *H. hirsuta* Austen was based. According to Austen (1909) *H. maculata* occasionally bites man.

The decided preference of *H. maculata* for cattle makes it extremely probable that it was originally a specific parasite of one of the wild ancestors of this domestic animal. The origin of the domestic races of cattle has given rise

to endless discussions. The most sensible view appears to be that expressed by C. Keller (1902), who admits two ancestors. The usual, larger type of cattle, now prevalent in Europe and America, was derived most likely from a wild species of Central Europe, the urus or "Ur," *Bos primigenius* Bojanus, which survived in the feral state until the beginning of the seventeenth century of our era. The more stubby, zebu type, usually kept in Eastern Africa, Southern Asia and Malaysia, had probably as ancestor the banteng, *Bos sondaicus* Schlegel and Muller, of the Oriental Region, still living in the wild state in some of the islands of the Malay Archipelago. The distribution of *H. maculata* corresponds surprisingly well with that of the zebu type of domestic cattle, so that one may suppose that the insect was originally an ectoparasite of the wild banteng. It would be of great interest to discover the fly on *Bos sondaicus* in the wild state.

It must be mentioned that no hippoboscid flies have ever been found on the water buffalo of Southern Asia nor on any of the African wild buffaloes. These animals are only remotely related to the domestic races of cattle.

AFFINITIES.—*H. maculata*, *H. rufipes* and *H. hirsuta* form a group of closely allied species, which differ from all the other members of the genus in having a row of setæ on the base of the third longitudinal vein and only one well-developed pulvillus. They also agree in most other peculiarities, except those mentioned in the key. The differences which separate them may appear slight, yet they are undoubtedly of specific value. I suspect that, before man contributed to extend their geographic and host range, every one of these species was confined to a rather small territory and to one or a few related hosts. *H. maculata* was probably then a parasite of wild cattle in the Oriental Region. *H. rufipes* lived on the wild equines of South Africa. *H. hirsuta* was restricted to the large antelopes of tropical Africa, as it is even nowadays.

H. maculata is rather variable in color, so that it has been fair game to the "splitters," as may be seen from the above list of synonyms. I hardly believe that any of these

names are worth retaining, even for varieties, and certainly none of them represent geographical races. Speiser (1900, Ann. Mus. Civ. Genova, XL, p. 560) states that in typical *H. maculata* the ground color of the thorax is black, while in the var. *aegyptiaca* Macquart it is reddish brown. It remains to be shown whether the reddish and black forms are geographically segregated. If they occur together, they may well be due to the age of the specimens, or even to their state of preservation.

I cannot regard *H. fossulata* Macquart as anything but a slight variation of *H. maculata*. Speiser (1904, Ann. Mus. Civ. Genova, XLI, p. 333) claims to have recognized *fossulata* in a specimen at the Vienna Museum, supposedly taken by Thorey in Surinam in 1859. This specimen differed from typical *H. maculata* only in having a chestnut-brown (not black) thorax, the three spots of the scutum mesonoti not connected, and the fore and middle legs with only the apex of the femora and two rings of the tibiae brownish black. These variations, however, are readily matched in a series of *H. maculata*. Macquart was uncertain about the locality of his specimen. If the specimen seen by Speiser actually came from Surinam, it must have been introduced there with cattle from the Old World.

5. *Hippobosca rufipes* v. Olfers

Hippobosca rufipes v. Olfers, 1816, "De Vegetativis et Animate Corporibus in Corpor. Anim. Reper. Comm.," I, p. 101 (not seen; type said to have been found on an ostrich at the Cape of Good Hope, by Lichtenstein). Austen, 1909, "Illustr. African Blood-Suck. Flies," p. 176, Pl. XIII, fig. 100 (♀).

Hippobosca albo-maculata Macquart, 1855, "Dipt. Exot.," Suppl. V, p. 128 (no sex given: "de l'Océanie, Cap des Aiguilles"; like the other Diptera described by Macquart in 1855 as coming from the "Cap des Aiguilles," this insect was obtained at Cape Aguilhas, South Africa).

Hippobosca albonotata Rondani, 1863, Arch. Zool. Anat. Fisiol., Modena, III, 1, p. 92 (no sex given; Caffraria).

Hippobosca maculata Macquart, 1835, "Hist. Nat. Ins. Dipt.," II, p. 638 (no sex given; Cape of Good Hope).
Not *H. maculata* Leach.

Hippobosca wahlenbergiana Jaennicke, 1867, Abh. Senckenberg. Naturf. Ges., VI, p. 406, Pl. XLIV, fig. 13 (♀; Caffraria).

Hippobosca marginata "Macquart" van der Wulp, 1894, Tijdschr. v. Entom., XXXVII, Versl., p. lxvi (as a synonym of *H. rufipes* v. Olfers).

Hippobosca camelopardalis Roubaud, 1925, Bull. Soc. Path. Exot., Paris, XVIII, p. 466, fig. 1 (♀; off giraffe; between Tabora and Tibu, Tanganyika Territory).

SPECIMENS EXAMINED.—Belgian Congo: Boma, off a mule (J. Rodhain); Uele District (J. Rodhain); Matadi (J. Ghesquière); Elisabethville, off mules imported from South Africa, June 26, 1912 (J. Bequaert); Biano Plateau, July 11, 1923 (Nockermans); Kapiri, July, 1912 (Leplae). Tanganyika Territory: 25 miles east of Ikoma, off eland, *Taurotragus oryx pattersonianus* Lydekker (J. P. Chapin). Southwest Africa: Walfish Bay (Michael Bequaert); Aroab (W. S. Brooks); Windhoek. Cape Province: Windsorton, off cattle (H. Brauns); Kimberley (C. P. Lounsbury). Portuguese East Africa: Lourenço Marques (C. W. Howard). Orange Free State: Jacobsdal (M. C. Mossol). Transvaal: Pretoria (R. Van Saceghem).

DISTRIBUTION.—This species was originally a South African insect, being now very common in the Cape Province, Basutoland, Southwest Africa, Orange Free State, Transvaal, Bechuanaland, and Natal. It is also found in Zululand and Southern Rhodesia. Its extension northward into Tanganyika Territory and the Belgian Congo may have been partly due to man. Wellman (1908, Bull. Soc. Ent. France, p. 77) has reported it from Benguela (Bihé and Chiyaka), and Austen (1909) from Angola (Bembe Mines, 7° 22' S.). Walker (1849, "List Dipt. Brit. Mus.," IV, p. 1141) has listed it from the Congo. In recent years it seems to be spreading rapidly beyond its original area.

HOSTS.—*H. rufipes* is nowadays primarily an ectoparasite of domestic equines (horses, mules, and donkeys). Although the type was said to have been obtained off an ostrich, it is more probable that the original host was one of the South African wild equines, *Hippotigris quagga* (Gmelin) or *H. zebra* (Linnæus), both of them formerly common in Cape Colony. There is, however, no record of hippoboscids having ever been taken on these animals. *H. rufipes* is also found at times on cattle and will occasionally settle on dogs or on man. Bedford (1927, 11th and 12th Repts. Dir. Vet. Res. South Africa, I, p. 782) mentions having taken it on the blue wildebeest, *Connochoetes taurinus* (Burchell), in the Northern Transvaal. The finding of this parasite on the East African eland, by Dr. J. P. Chapin, is also of special interest.

H. camelopardalis Roubaud was taken on giraffe, *Giraffa camelopardalis* (Linnæus), in Tanganyika Territory, by my friend, Dr. J. Rodhain. It appears to be identical with *H. rufipes*, to judge from the excellent figure and the brief description; the latter, however, does not mention any of the morphological characters here used to separate the species of Hippobosca.

It was believed at one time by Sir Arnold Theiler that *H. rufipes*, as well as *H. maculata* Leach, were the carriers of a trypanosome (*T. theileri*) found in the blood of cattle in the Transvaal. But the possibility of infection from other sources was not excluded in Theiler's experiments. Moreover, *Trypanosoma theileri* is found all over the world, even in regions where cattle never are infested with hippoboscids, so that the role of these flies as transmitters is most improbable. Nöller's recent work seems to indicate that certain tabanids are the normal carriers of *T. theileri*.

AFFINITIES.—These have been discussed under *H. maculata*.

6. *Hippobosca hirsuta* Austen

Hippobosca hirsuta Austen, 1911, Bull. Ent. Res., II, p. 169, fig. 1a (♀ ♂; off waterbuck, *Kobus defassa* Rüppell; Mohokya, Toro Plains and northeast shore of

Lake Ruisamba; both localities in Uganda). S. A. Neave, 1912, *Loc. cit.*, III, pp. 311 and 322. Kinghorn, Yorke and Lloyd, 1913, *Ann. Trop. Med. Paras.*, VII, p. 297.

Hippobosca hirsuta var. *neavei* Austen, 1911, *Bull. Ent. Res.*, II, p. 171, fig. 1b (♀ ♂; off waterbuck, *Kobus defassa* Rüppell; junction of the Mpamadzi and Luangwa Rivers, Upper Luangwa River, and Mid Luangwa River; all in Northeastern Rhodesia). S. A. Neave, 1912, *Loc. cit.*, III, pp. 311, 314 and 315.

SPECIMENS EXAMINED.—Belgian Congo: Rutshuru Plains, off waterbuck, *Kobus defassa* Rüppell, March 24, 1927 (H. Coolidge and C. Whitman); Western shore of Lake Edward, off the same host (H. Leboutte); Aka, Uele District, off the same host (J. Rodhain).

DISTRIBUTION.—This species is known from Uganda and the adjoining northeastern regions of the Belgian Congo. The var. *neavei* occurs in Northeastern Rhodesia and Nyasaland.

HOSTS.—*H. hirsuta* seems to be a specific parasite of waterbucks and allied antelopes. The host list includes, at present, *Kobus defassa* Rüppell, *Kobus ellipsiprymnus* Ogilby and *Adenota vardoni* (Livingstone).

Austen's var. *neavei* differs from the typical form only in the shape of the median, straw-yellow spot of the scutellum, which is small and more or less triangular, with apex of triangle resting on hind margin; instead of being large, rounded in front and flattened behind. In the few specimens which I have seen, the spot of the scutellum is of the typical form.

AFFINITIES.—These have been discussed under *H. maculata*.

7. *Hippobosca struthionis* O. E. Janson

Hippobosca struthionis O. E. Janson, in E. Ormerod, 1889, "Notes and Descriptions of a few Injurious Farm and Fruit Insects of South Africa," p. 56, fig. 23 (no sex

given; off ostriches; Mt. Steward, Cape Province, South Africa). Ormerod, 1890, *Agri*, Jl., Cape Town, II, p. 293. Austen, 1903, *Ann. Mag. Nat. Hist.*, (7) XII, p. 259 (♀ ♂); 1909, "Illustr. African Blood-Suck. Flies," p. 171, Pl. XIII, fig. 98 (♀). Speiser, 1909, in Sjöstedt, "Wiss. Ergebn. Schwed. Zool. Exp. Kilimandjaro," II, Abt. 10, 1, p. 5. S. A. Neave, 1912, *Bull. Ent. Res.*, III, pp. 311, 317, and 320. Bedford, 1927, 11th and 12th Repts. Dir. Vet. Res. South Africa, I, p. 782.

Hippobosca struthionis var. *massaica* Speiser, 1909, in Sjöstedt, "Wiss. Ergebn. Schwed. Zool. Exp. Kilimandjaro," II, Abt. 10, 3, p. 30 (off *Struthio camelus massaicus* Neumann; Tanganyika Territory near Mt. Kilimanjaro).

SPECIMENS EXAMINED.—Cape Province: many specimens without definite locality (C. P. Lounsbury); Willowmore, numerous specimens off ostriches, *Struthio camelus australis* Gurney (H. Brauns). Southwest Africa: Aroab (W. S. Brooks).

DISTRIBUTION.—*H. struthionis* has been recorded from the Cape Province of South Africa, Transvaal, Tanganyika Territory, and Kenya Colony. It probably occurs over the entire range of *Struthio camelus* Linnæus, which nowadays extends over the Arabian-Syrian desert, the Sudan, and parts of East and South Africa (see Reichenow, 1900, *Die Vögel Afrikas*, I, pp. 5-13). Even within historic times, however, this bird was more widely distributed in Africa than at present. In former geologic periods, the Struthionidæ covered also much of Central Asia and Southern Europe, as shown by fossil remains.

HOSTS.—This fly is a strictly specific parasite of the ostrich, all the living forms or races of which are now regarded as belonging to a single species. The parasite is unusually abundant on its host in South Africa.

AFFINITIES.—In many particulars *H. struthionis* occupies an isolated position in the genus and it is probably

not related in any way to the other living species. In general appearance it is more like the usual bird hippoboscid flies than like the other Hippoboscæ. The legs are unusually long and slender, and the empodium is unique.

8. *Hippobosca camelina* Leach

Hippobosca camelina Leach, 1817, "Gen. Spec. Eprobosci. Ins.," p. 10, Pl. XXVII, figs. 11-14 [called *Hippobosca cameli* in the Explanation of Plates, p. 20] (no sex given; Egypt). Dufour, 1858, Ann. Soc. Ent. France, (3) VI, Bull. Séances, p. ciii (described as a new species, from Southern Algeria). Speiser, 1902, Zeitschr. Syst. Hym. Dipt., II, p. 176. Austen, 1903, Ann. Mag. Nat. Hist., (7) XII, p. 257. Theobald, 1906, 2d Rept. Wellcome Res. Labor. Khartoum, p. 92, figs. 48, 50, and 53; Pl. X, fig. 2.

Hippobosca bactriana Rondani, 1878, Ann. Mus. Civ. Genova, XII, p. 165 (no sex given; Persia and Massaua, Eritrea).

Hippobosca dromedarina Speiser, 1902, Zeitschr. Syst. Hym. Dipt., II, p. 176 (new name for the North African parasite of dromedaries, which Rondani called *H. camelina*).

SPECIMENS EXAMINED.—Palestine: Petra (W. M. Mann). Arabia: Akaba, off camel (W. M. Mann); Aden, off *Camelus dromedarius* Linnæus, May 9, 1927 (J. Bequaert). Somaliland: Berbera (A. D. Smith). Kenya Colony: Archers Post, Northern Guaso Nyero River, November 3, 1911 (R. B. Woosnam). Egypt: Lisht (A. Hrdlicka). Tunis: Djerba (A. Weiss).

DISTRIBUTION.—This parasite is found throughout North Africa, Egypt, Syria, Palestine, Asia Minor, Persia, Afghanistan, Arabia, the Sudan (as far west as Mauretania and the Senegal), and northeastern Africa (as far south as Kenya Colony). All of this territory is probably part of its original distribution. It has been introduced recently

by man into Southwest Africa. Massonat (1909, Ann. Université Lyon, N. S. CXXVIII, p. 248) mentions a specimen of *H. camelina* collected off a horse in the Camargue, Southern France, the only record of the species, so far as I know, from the European shore of the Mediterranean.

HOSTS.—*H. camelina* is the specific parasite of the two-humped camel, *Camelus bactrianus* Linnæus, and of the one-humped dromedary, *Camelus dromedarius* Linnæus, which are now generally regarded as two domestic races of one single species. The ancestral form is found even now in the wild state in some of the deserts of Central Asia (Gobi, River Ob; western Mongolia). This wild ancestor had formerly a much wider distribution (see Keller, 1902).

AFFINITIES.—*H. camelina* is not closely allied to any other species of Hippobosca. The two pairs of vertical bristles and the complete abortion of the pulvilli are aberrant features not found elsewhere in the genus.

Rondani (1878) and Speiser (1902) have attempted to draw a specific distinction between the flies found on the camel and those from the dromedary, the supposed differences being entirely based upon color characters. After examining many specimens from different localities, I have reached the same conclusion as Austen (1903), that these two forms cannot be separated even as varieties. In coloration *H. camelina* is very variable, even in a lot taken from the same host in one locality. The variation affects the markings of the thorax, as well as the color of the hair on the fronto-clypeus and at the tip of the abdomen. Moreover, since the camel and the dromedary are only races obtained in domestication from a common ancestor, one could hardly expect specific or sub-specific differences in their parasites.



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