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Distribution of Fleas (Siphonaptera) in Bird-Nests, Bird Siphonaptera on Mammalia and the Medical Importance of Interspecific Flea Transmission in Mongolia

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Distribution of Fleas (Siphonaptera) in bird-nests, bird Siphonaptera on mammalia and the medical importance of interspecific flea transmission in Mongolia

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Abstract

Starting in the 60s of the last century a huge amount of material from mammals and birds was collected in Mongolia. The according results were published in "Erforschung biologischer Ressourcen der Mongolei, Volume 1-10" and represented on conferences in Halle, Moscow, Irkutsk, Ulaanbaatar, Bratislava and the Entomological Review St. Petersburg.

A big part of the collected material consisted of ectoparasites analysed by experts from Mongolia, Germany, England, Russia, Poland, Czech Republic and Slovakia resulting in newly described species along with zoogeographical and ecological profiles.

During the years 1974-2007 material from 321 nests of 38 bird taxa were obtained. 157 nests of 25 bird taxa were positive for fleas resulting in 5532 collected specimen. 41 flea-species were detected. The flea-species with the highest spatial distribution are *Ceratophyllus tribulis* and *C.vagabundus* mostly parasiting on Passeriformes. *Ceratophyllus maculatus* and *C.caliotes,* specific parasites *on Delichon urbica* and *Hirundo rustica*, show the highest abundance of the analysed fleas. In the nests of Apodidae and Hirundinidae, 90 % of the analysed fleas-species were *Ceratophyllus maculatus.*

Keywords: Siphonaptera, Mongolia, Aves, Mammalia, medical importance, ectoparasites

1. Introduction

Mongolia´s vast space, it´s six vegetation zones and diversified geomorphology delivers the best conditions for a high diversity of many life forms, including the nest-fleas of birds.

Nonetheless the ectoparasites of birds and their nests are merely analysed in Mongolia. Out of the approx. 300 Mongolian bird-species only about 15% of their Siphonaptera are analysed so far. The Siphonapterofauna of Mongolian birds was described and analysed by LABUNETS (1967 a,b) and several other studies including Mammalian Flea species which were summarized by KIEFER (1979), KIEFER et al. (1984, 1985) and GONCHAROV (1989). Our study represents the current state of Siphonaptera research in Mongolia.

2. Materials and Methods

During the years 1971-2006, 321 nests of 38 bird taxa were obtained by members of the National Centre for Infectious Diseases with Natural Foci (NCIDNF) Ulaanbaatar, Mongolian-German expeditions since 1962, the Mongolian State University Ulaanbaatar, Mongolian Academy of Science and Mongolian-Slovak expeditions.

157 nests out of 25 taxa were positive for fleas resulting in 5532 collected specimen. The collected fleas were stored in 70 % - 99 % ethanol. The majority was embedded in Canada balsam, part of them was determined directly from ethanol for further virological and microbiological analyses. The material was evaluated according to occurrence intensity (average number of fleas from a positive host nest) and dominance (percental presence of each taxon in the total number of obtained flea specimen from one host species).

3. Results

Occurrence of fleas in bird nests

The records about known geographical distribution of flea hosts in Mongolia and their distribution were obtained from studies by: BAVAASAN (1978), BAVAASAN et al. (1977), BYAMBA et al. (2007), CYPRICH et al. (1978, 2001), DARSKAYA (1950), DOVTSCHIN et al. (1978), LEWIS (1972, 1973, 1974 a, b, c, 1975, 1993), GONCHAROV et al. (1989), M. KIEFER (1979, 1993), M. KIEFER et al. (1984, 1986), D. KIEFER et al. (2006), LABUNETS (1959, 1967a, 1967b, 1971) LAZAREVA et al. (1975) and SCALON (1966).

In Mongolia 41 Siphonaptera-species were detected on birds and in their nests.

Mammalian fleas

1. *Amphalius runatus runatus* (Jordan & Rothschild, 1923)
Distribution: Siberia, Central Asia, Northern Mongolia
Host bird: *Oenanthe* sp.
Host mammal: *Ochotona* sp.*, Alticola* sp., *Lasiopodomys* sp.*, Spermophilus* sp.

***2. Amphipsylla primaris mitis* Jordan, 1929**
Distribution: Central-Eastern Siberia, Mongolia, China
Host bird: *Motacilla alba*, *Passer montanus*, *Pica Pica*
Host mammal: *Microtus* sp., *Cricetulus* sp., *Alticola* sp.

3. *Amphipsylla primaris primaris* Jordan & Rothschild, 1915
Distribution*:* Altay-Sayan, Western-, Northern-, and Central Mongolia
Host bird: *Eremophilla* sp.
Host mammal: known from a variety of hosts

4. *Chaetopsylla homoea homoea* Rothschild, 1906
Distribution: Europe, Siberia, Tibet, Mongolia
Host bird: *Falco* sp.
Host mammal: Mustelidae

5. *Callopsylla caspia gaiskii* (Vovchinskaya, 1950)
Distribution: Altay-Sayan, Western - and Central Mongolia
Host bird: *Falco* sp.
Host mammal: *Alticola* sp., *Allactaga* sp., *Eulagurus* sp.

6. *Catallagia fetisovi* Vovchinskaya, 1944
Distribution: Altay-Sayan, Northern Mongolia
Host bird: *Circus* sp.
Host mammal: *Clethrionomys* sp.*, Alticola* sp.*, Lasiopodomys* sp.*, Marmota* sp.

7. *Citellophilus sungaris sungaris* (Jordan, 1929)
Distribution: East-Asia, Mongolia (with *Spermophilus undulatus*)
Host bird: *Falco* sp.
Host mammal: *Spermophilus* sp.*, Vulpes* sp.*, Meriones* sp.*, Lasiopodomys* sp.

8. *Citellophilus altaicus* (Ioff, 1936)
Distribution: Altay-Sayan,Western Mongolia
Host bird: *Falco* sp.
Host mammal: *Spermophilus* sp.*, Ochotona* sp.*, Alticola* sp.

9. *Ctenophyllus hirticrus* (Jordan & Rothschild, 1923)
Distribution: Siberia, East Asia, Mongolia
Host bird: *Oenanthe* sp.
Host mammal: *Ochotona* sp.*, Alticola* sp. and a variety of hosts

10. *Frontopsylla elata elata* (Jordan & Rothschild, 1915)
Distribution: East Asia, Western Mongolia
Host bird: *Oenanthe* sp.
Host mammal: *Spermophilus* sp.*, Ochotona* sp.*, Putorius* sp.*, Alticola* sp.

11. *Frontopsylla elatoides elatoides* Wagner, 1928
Distribution: Siberia, Central Asia, Western Mongolia
Host bird: *Saxicolla* sp.
Host mammal: *Ochotona* sp.*, Spermophilus* sp. and a variety of hosts

12. *Frontopsylla luculeta luculenta* (Jordan & Rothschild, 1923)
Distribution: East Asia, Eastern Mongolia
Host bird: *Oenanthe* sp.
Host mammal: Known from a variety hosts

13. *Frontopsylla luculenta parilis* Jordan, 1929
Distribution: Altay-Sayan, Tuva, Mongolia (excluding Southern Mongolia)
Host bird: *Falco* sp.
Host mammal: *Lasipodomys* sp.*, Marmota* sp.*, Meriones* sp.*, Spermophilus* sp.

14. *Frontopsylla hetera* Wagner, 1933
Distribution: Siberia, Central Asian, Central Mongolia
Host bird: *Hirundo* sp.*, Oenanthe* sp.
Host mammal: Various rodents and *Ochotona* sp.

15. *Neopsylla abagaitui* Ioff, 1946
Distribution: Siberia, East Asia, Northern Mongolia
Host bird: *Motacilla alba*
Host mammal**:** *Spermophilus* sp.*, Meriones.* sp.*, Lasiopodomys* sp.*,Ochotona* sp.

16*. Neopsylla mana* Wagner, 1927
Distribution: Northern Asia, Central Asia, Gobi Altay, Central Mongolia
Host bird: *Oenanthe* sp.*, Riparia riparia*
Host mammal: *Ochotona* sp.*, Marmota* sp.*, Alticola* sp.

17. *Neopsylla pleskei orientalis* Ioff & Argyropulo, 1934
Distribution: East Asia, Mongolia
Host bird: *Passer montanus, Riparia riparia*
Host mammal**:** *Lasiopodomys brandtii* as main host and rodents

18. *Megabothris rectangulatus* (Wahlgren, 1903)
Distribution: Europe, Asia, North-West Mongolia
Host bird: *Circus* sp.
Host mammal: Microtinae

19. *Ophthalmopsylla praefecta praefecta* (Jordan & Rothschild, 1915)
Distribution: Mongolia, Mandzhuria
Host bird: *Oenanthe* sp.
Host mammal: *Allactaga* sp.*, Dipus* sp.

20. *Paradoxopsyllus dashidorshii* Scalon, 1953
Distribution: Western and Northenr Mongolia, Gobi Altay
Host bird: *Hirundo rustica, Oenanthe* sp.
Host mammal: Rodents and genus *Ochotona*

21. *Paramonopsyllus scalonae* (Vovchinskaya,1950)
Distribution: Tuva, Western and Central Mongolia
Host bird: *Oenanthe* sp.
Host mammal: *Ochotona* sp.*, Alticola* sp.*, Cricetulus* sp.

22. *Rhadinopsylla li transbaikalica* Ioff & Tiflov, 1947
Distribution: Altay-Sayan, Central and Northern Mongolia
Host bird: *Falco* sp.
Host mammal**:** *Spermophilus* sp.*, Marmota* sp.*, Putorius* sp.*, Alticola* sp.

23. *Rhadinopsylla dahurica diclinica* Tiflov, 1937
Distribution: Altay-Sayan Mongolian Altay
Host bird*: Circus* sp.*, Oenanthe* sp.
Host mammal: *Ochotona* sp.*, Spermophilus* sp.*, Marmota* sp.*, Meriones* sp.

24. *Wagnerina antiqua* Scalon, 1953
Distribution: Central and Western Mongolia
Host bird: *Hirundo rustica, Oenanthe* sp.
Host mammal: *Microtus* sp*., Alticola* sp*.,* main host *Ochotona* sp*.*

Bird Fleas

25. *Ceratophyllus borealis* Rothschild, 1907
Distribution: Holoarctic region, Mongolian Altay, Northern Mongolia
Host bird: *Hirundo rustica* and other Hirundinae

26. *Ceratophyllus caliotes* Jordan, 1937
Distribution: Caucasus, Tyan Shan, Siberia, Central Mongolia
Host bird: *Delichon urbica, Apus pacificus, Hirundo rustica*

27. *Ceratophyllus farreni chaoi* Smit & Allan, 1955
Distribution: East Asia, Mongolia, Khangay
Host bird: *Delichon urbica, Hirundo rustica*

28. *Ceratophyllus gallinae* (Schrank, 1803)
Distribution: Palaearctic region, Mongolian Altay
Host bird: wide variety of nesting birds
Host mammal: *Spermophilus undulatus*

29. *Ceratophyllus garei* Rothschild, 1902
Distribution: Holoarctic region, Mongolian Altay and Khangay
Host bird: Preferred bird host *Passer montanus*, nesting on soil
Host mammal: *Alticola strelzowii, Mesechinus dauricus, Marmota sibirica, Meriones unguiculatus, Microtus gregalis, M. oeconomus, Ochotona daurica, O. pallasii, Scirtopoda tellum, Spermophilus undulatus*

30. *Ceratophyllus hirundinis* (Curtis, 1826)
Distribution: Palaearctic region, Mongolian Altay and Khangay
Host bird: *Delichon urbica* and *Hirundapus daurica,* Hirundinidae

31. *Ceratophyllus maculatus* Wagner, 1927
Distribution: Central Asia, Siberia, Tuva, Western Mongolia
Host bird: *Delichon urbica, Apus pacificus, Hirundapus pacificus,* Hirundinidae

32. *Ceratophyllus orites* Jordan, 1937
Distribution: Tyan Shan, Kirgizia, Mongolian Khangay
Host bird: *Delichon urbica*
Host mammal: *Meriones unguiculatus*

33. *Ceratophyllus sinicus* Jordan, 1932
Distribution: Tyan Shan, Central Asia, Baykal, Western and Central Mongolia
Host bird: Genus *Oenanthe, Falco* sp*. and Saxicola* sp., nesting on soil
Host mammal: Apodemus peninsulae, Marmota sibirica, Mustela erminea, Ochotona daurica, O. pallasii, Phodopus roborowskii, Spermophilus undulatus, S. alashanicus

34. *Ceratophyllus styx riparius* Jordan & Rothschild, 1920
Distribution: Palaearctic region, Eastern Mongolia- Khangay, Khentey,
Host bird*: Riparia riparia, Pyrhocorax pyrhocorax* and in nest of other bird (occurs seldom)
Host mammal*: Marmota sibirica*

35*. Ceratophyllus tribulis* Jordan, 1926
Distribution: Palaearctic region, Mongolia
Host bird: wide variety of nesting birds, *Anthus* sp*., Apus pacificus, Columba livia, Corvus daurica, Dendrocopus* sp*., Motacilla alba, Passer montanus, Pica pica, Riparia riparia*
Host mammal: *Allactaga sibirica, Apodemus peninsulae, Cricetulus barabensis, Marmota sibirica, Ochotona daurica.*

36. *Ceratophyllus vagabundus dimi* Mikulin, 1958
Distribution: Caucasus, Central Asia, Southern Siberia, Central Mongolia
Host bird: *Sturnus* sp., *Hirundo rustica, Pyrhocorax pyrhocorax, Riparia riparia*

37. *Ceratophyllus vagabundus insularis* Rothschild, 1906
Distribution: Holoarctic region, Central Mongolia and the Great Lakes
Host bird: *Columba livia, C. rupestris, Emberizia* sp., *Oenanthe* sp., *Pica pica, Pyrhocorax pyrhocorax, Saxicola* sp., known from a variety of birds but mainly on Corvidae
Host mammal: *Myotis mystacinus*

38. *Frontopsylla cornuta* Ioff, 1946
Distribution: Tyan Shan, Kazakhstan, Tuva, Mongolia - Khangay
Host bird: *Delichon urbica* as main host

39. *Frontopsylla lapponica prior* Scalon, 1965
Distribution: Tuva, Northern and Western Mongolia
Host bird: *Oenanthe* sp.

40. *Frontopsylla frontalis baikal* Ioff, 1946
Distribution: Tuva, Cisbaikal, Tyan Shan, Western and Central Mongolia
Host bird: Numerous bird species
Host mammal: *Ochotona* sp.

41. *Monopsyllus indages* Rothschild, 1908
Distribution: Holoarctic region, Great Lakes, Central and Northern Mongolia
Host bird: *Dendroscopus* sp., known from a variety of birds nesting in dens of *Eutamias* sp. and *Sciurus* sp.
Host mammal: Species associated with *Eutamias* sp., *Sciurus* sp. and bird nests

Frontopsylla cornuta was detected by our expedition for the fist time at Ögiy nuur (17.07.1978), KIEFER et al. (1986) and not like wrongly reported by CYPRICH et al. (2001).

Bird fleas detected on mammals in Mongolia

Ceratophyllus sinicus
Mammal: *Apodemus peninsulae, Marmota sibirica, Mustela erminea, Ochotona daurica O. pallasii, Phodopus roborovskii*

Ceratophyllus tribulis
Mammal: *Allactaga sibirica, Apodemus peninsulae, Cricetulus barabensis, Marmota sibirica, Ochotona daurica*

Ceratophyllus vagabundus
Mammal: *Myotis mystacinus*

Ceratophyllus garei
Mammal: *Alticola* sp., *A. strelzowii, Mesechinus dauuricus, Marmota sibirica, Meriones unguiculatus, Microtus gregalis, M. oeconomus, Ochotona daurica, O. pallasii, Scirtopoda tellum, Spermophilus undulatus*

Ceratophyllus gallinae
Mammal: *Spermophilus undulatus*

Ceratophyllus orites
Mammal: *Martes zibelina*

Ceratophylus styx riparius
Mammal: *Marmota sibirica*

Fleas were also captured from the following bird species or their nests:

Alauda sp., *Anthus* sp., *Athene noctua, Apus pacificus, Circus macrourus, Columba livia, C. rupestris, Corvus daurica, Delichon urbica, Dendrocopus* sp., *Emberizia* sp., *Eremophila alpestris, Falco* sp., *Hirundapus daurica, Hirundo rustica, Larus* sp., *Milvus korschun, Motacilla alba, Larus* sp., *Oenathe oenanthe, O. isabelina, O. hispanica, Passer montanus, Pica pica, Pyrrho-*

corax pyrrhocorax, Riparia riparia, Saxicola, Upupa epops, and *Pyrgilauda* sp. (D. KIEFER et al. 2006).

The detection of mammal-fleas on birds indicates close contact of these two groups. The following mammal-flea-species are relevant:

Amphipsylla kuznetzovi, Catallagia fetisovi, Citellophilus altaicus, Citellophilus sungaris, Ctenophyllus hirticrus, Frontopsylla lapponica prior, F. luculenta parillis, Chaetopsylla homoea homoea, Megabothris rectangulatus, Neopsylla mana, Oropsylla alaskensis, Rhadinopsylla dahurica diclinica, Rh.li transbaikalica, and *Paramonopsyllus scalonae.*

The flea-infestation of birds depends on many factors like the distribution of the host bird species, their nesting behaviour and their overall contact to mammals. The flea-species with the highest spatial distribution are *Ceratophyllus tribulis* and *C.vagabundus* mostly parasiting on Passeriformes. *Ceratophyllus maculatus* and *C. caliotes,* specific parasites on *Delichon urbica* and *Hirundo rustica* show the highest abundance of the analysed fleas. In the nests of Apodidae and Hirundinidae, 90 % of the analysed fleas-species were *Ceratophyllus maculatus.* The highest diversity of flea-species was detected among ground dwelling birds occupying nests in the ground and between rocks as well as synanthropic species like *Hirundo* and *Passer* sp. Birds nesting in tree holes and crowns showed a minimal flea-infestation, except of raptors.

4. Medical importance of bird transmitted fleas

The importance of birds as transmitters of ectoparasites is a well known fact for a long time. HOOGSTRAAL (1963, 1964) analysed Ixodidae as disease vectors in the Mediterranean area during Spring- and Autumn-migrations in the NAMRU 3 project. ROSICKY (1957) analysed birds and their ectoparasites as possible disease transmitters over long distances. Special attention was paid to birds as transmitters of fleas and ticks in the publications from GUSEV & BEDNYI (1960), GUSEV et al. (1962), KUNICKIJ & GAUZSTEIN (1963), TER-VARTANOV et al. (1956), and SHIRANOVICH & CHUMAKOVA (1961).

A bird-genus of great importance regarding the transmitting hosts of *Yersinia pestis* and other diseases with natural foci is *Oenanthe*. Four *Oenanthe* species are known from Mongolia, *Oenanthe oenanthe, O. deserti, O. isabellina* and O*. pleschanka.*

On *Oenanthe isabellina*, *Ceratophyllus sinicus* (dominance 70 %) and *Frontopsylla frontalis baikal* (dominance 15 %) are the dominant flea-species. In the nests of *Oenanthe oenanthe*, *Ceratophyllus borealis* (dominance 65 %) is the dominant flea-species.

Except from the specific bird-fleas, other flea-species were detected in the nests of *Oenanthe oenanthe*: *Amphalius runatus, Citellophilus sungaris sungaris, Frontopsylla hetera, Paramonopsyllus scalonae, Frontopsylla elata, Frontopsylla elatoides elatoides* as well as *Ctenophyllus hirticrus,* which are known parasites of the genera *Ochotona* and *Spermophilus*. This finding proves a broad contact among birds and mammals and delivers an explanation for the large distances between natural plague foci in Southern Mongolia and China.

During epizootic states when all mammals are dead, representatives of the genus *Oenanthe* act as surrogate-hosts for mammal-fleas since birds are inappropriate hosts for *Yersinia pestis*. The dens of the genera *Ochotona* and *Spermophilus* are often inhabited by *O. isabellina* because they are lined with fur and fine debris thus offering ideal nesting conditions.

KUNICKIJ & GAUZSTEIN (1964) emphasise the importance of the genus *Oenanthe* in areas with plague occurrence. This genus occurs in any area where plague was detected, its distribution and close contact to mammals which are known carriers of plague in Mongolia reflects the important role the genus *Oenanthe* plays in the transmission and circulation of plague.

Despite of its importance, few data are available concerning the genus *Oenanthe*, its contact to rodents, especially *Rhombomys opimus*, during migration flights and the relevance for plague transmission in Mongolia.

The Importance of nest-contact of the genus *Oenanthe* and other birds which use the dens of Gerbils was analysed by KUNICKIJ & GAUZSTEIN (1964) regarding the effects on plague-transmission over long distances. The research was performed in the primary plague-foci of Central Asia. Four flea-species were detected on *Rhombomys opimus, Echidnophaga oschanini*, *Xenopsylla gerbilli minax*, *Xenopsylla hirtipes* and *Ctenophthalmus dolichus* as well as the bird-fleas *Ceratophyllus galinae* and *Frontopsylla frontalis*. The latter flea-species was only detected when the birds intruded the area and nested in the dens of the genera *Rhombomys* und *Meriones*. During this period, the fleas could also be detected in the nests. The genus *Oenanthe* uses the dens of the genera *Rhombomys*, *Spermophilus* and *Ochotona* for nesting which is confirmed by frequent detection of gerbil-fleas on the representatives of the genus *Oenanthe*. The siphonapterofauna of the genus *Oenanthe* can show a rate of 18 % - 23 % of gerbil-fleas.

The optimum for the occurrence of gerbil-fleas on *Oenanthe* sp. is reached in a short period from the end of Mach till the beginning of April. Beginning with the first week of April the number of bird-fleas on representatives of the genera *Rhombomys* and *Meriones* decrease continuously. Especially representatives of the gerbil-flea-genus *Xenopsylla* show an increased activity during this period in the spring resulting in contact to the genus *Oenanthe*.

Factors affecting the contact of Gerbils and Birds can be divided in 5 categories (GAUZSTEIN & KUNICKIJ 1964):

1. Migrating and foraging birds have permanent contact to rodents and their dens whereas large populations are involved in the migration.
2. On the migration-route many rodents and rodent dens are present which can be acquired
3. Gerbil-fleas gain high population numbers, migrate to the den entrance where birds are infested and kept as hosts for a transport-sufficient period.
4. After transportation the fleas are capable of infesting new hosts and dens
5. The point of time at which the flea-transport occurs correlates with the dates epizootic outbreaks occur.

Despite of its importance few researches were published on the topic of *Oenanthe* sp. and its contact to rodents. From bordering countries like China, *Ceratophyllus sinicus, C. garei* and *Frontopsylla frontalis* were reported on *Oenanthe* sp. LIU ZHIYING (1986), LIU JUN (1997), but there are no reports of bird-rodent contact.

In a study of wheatears in the Zavkhan and Uvsnur Ajmak , it was found that *Oenanthe isabellina, O. hispanica, O. oenanthe and O. deserti* are widely distributed in the mountain steppe, the first being the most common species and the last the least common. In 1970 and 1973, *Oenanthe xanthoprymna*, a wheatear of the Pamirs, was observed. Ectoparasites were found only on *O. isabellina*, and were uncommon; of 376 birds examined, 11 were infested with fleas, 9 with gamasidae mites and one with ticks. 48 fleas of 8 species were collected, together with 50 mites of 5 species, 8 examples *of Dermacentor nuttalli Olenev* and single examples of Anoplura and Mallophaga. The most common fleas were *Ceratophyllus sinicus* and *Frontopsylla frontalis baikal*, which parasitise rodents and frequent the runways of their burrows. The remaining fleas were also parasites of rodents. In 9 nests of *O. isabellina,* fleas of 9 species were found, and here also *C. sinicus* and *F. f. baikal* were the most common species, and the others, like them, were parasites of rodents. Bacteriological examination of 414 wheatears for plague did not yield positive results, but a serological investigation of a specimen of *O. isabellina* in 1973 revealed the presence of specific antibody to plague. Five strains of *Erysipelothrix* and 4 of *Pasteurella* were isolated from wheatears and their nests, 8 of the strains being found in the Zavkhan Province (LIPAEV et al. 1975).

From an epidemiologic point of view the parasites of *Hirundo rustica* are of special interest. Strains of *Yersinia pseudotuberculosis* were isolated from nymphs of Gamasidae-ticks (SOTNIKOVA et al. 1975) and the flea species *Ceratophyllus orites, C. caliotes, C. maculatus, Dermanyssus hirundinis* in the Northwestern parts of Mongolia.

According to the analysed literature, gerbil-fleas from Southern Mongolia were not collected in a period when birds and gerbils are likely to have contact on the ground. D. KIEFER et al. (2006) supports the contact of birds and mammals based on material from higher regions in Northern Mongolia in summertime.

The most recent proof of the importance of the genus *Oenanthe* is the isolation of plague strains from two locations in Mongolia. From the natural foci Khoid khabchuu of Bukhmurun sum Uvsnur Ajmak, a plague strain was isolated from the fleas *Ceratophyllus sinicus, Frontopsylla hetera* and *Citellophilus sungaris* extracted from two dead bodies of *Oenanthe* sp. in an *Ochotona pallasii* den in 1969. In 2006 a plague strain was isolated from an *Oenanthe oenanthe* in Uburteel´s Shiree in Galuut sum, Bayankhongor Ajmak (BYAMBAA et al. 2007).

5. Discussion

Finally the importance of wheatears and other birds for the transmission and circulation of plague and other diseases with natural foci is obvious regarding the presented data none the less this topic still lacks the attention it deserves. Further research is crucial for an advanced understanding of the natural cycles involved in this parasite-host relation and its doubtlessly immense epidemiological importance.

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