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WATER MITES: BEAUTY AND PEST **Wenfei Liao**

When collecting diving beetles from my activity traps, sometimes I couldn't help noticing some tiny, bright-coloured creatures swimming in the traps too. They are water mites (Figure 1) and look cute and harmless. In fact, their larvae can be parasites of many insects, including our beloved water beetles, such as dytiscids (Figure 2).

Figure 1 A water mite. From Wikimedia Commons

Water mites have a complex life cycle. Their adults lay eggs in the water, which hatch to parasitic larvae. The larvae need to go through three developmental forms before they become adults. These are protonymph, deutonymph, and tritonymph. Their protonymphs and tritonymphs are inactive, while their deutonymphs and adults are predaceous (Smith *et al*. 2009). Water mites often rely on aquatic insects that are capable of flight for dispersal (Zawal 2003). The larvae of most water mite species are ectoparasites, living on the outside of their hosts (Aykut & Esen 2017). Water mites parasitic on insects can be classified into three groups: 1. whose adults are permanently connected with water, including aquatic true bugs, such as *Ranatra linearis* (L.); 2. whose adults are periodically out of water, such as diving beetles; 3. whose adults are permanently out of water, such as dragonflies (Böttger 1976; Zawal 2003). Parasitic larvae utilise visual, tactile and chemical cues to seek their hosts (Smith *et al*. 2009).

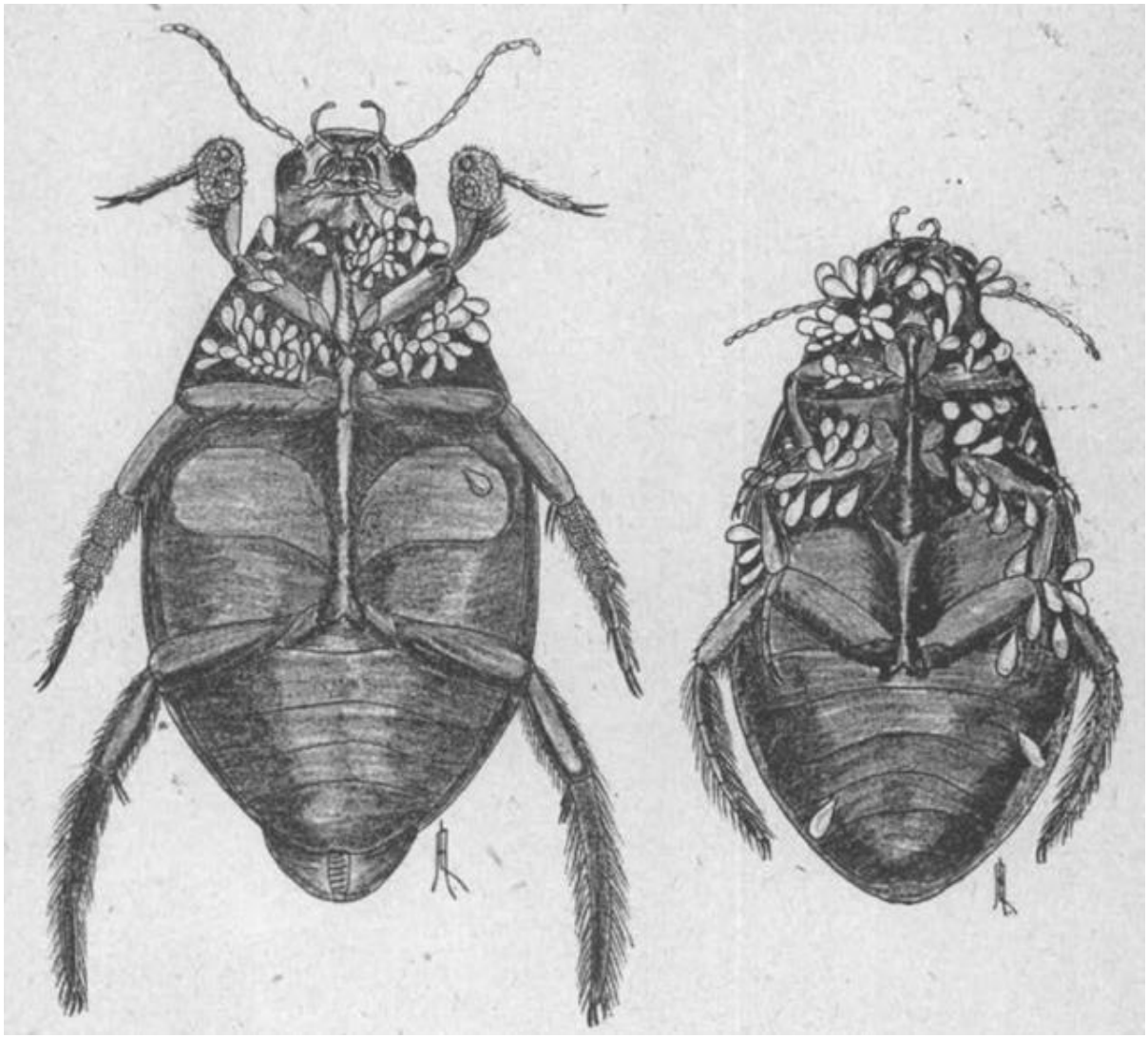

Figure 2 Larvae of water mites are ectoparasites of many insects, including diving beetles. I also found water mite larvae on some specimens of *Dytiscus marginalis*. Picture from Brumpt 1929

The larvae of some water mite species were even first described from water beetles (e.g. Lanciani 1970a; Arjomandi *et al*. 2019). Water mites that parasitise water beetles seem to have adapted their own life cycle to water beetles' life cycle. For example, the larvae of *Eylais* have the highest parasitism rate on *Dytiscus alaskanus* when the beetle has its population peak during early spring (Aiken 1985). Parasitic water mite larvae are thought to take advantage of water beetles' pupation stage, during which they can easily pierce into the relatively soft skin of beetle pupae (Aykut & Esen 2017). This view, however, may not always be true because most dytiscid species pupate out of water, somewhat too distant from water for those mite species whose larvae are aquatic (Mortazavi *et al*. 2018).

Water mites parasitise their hosts for two main reasons: food source and dispersal. Some mite larvae prefer attaching to the costal–subcostal area of membranous wings, because the strong afferent flow of blood going through the area can provide rich food source (Aiken 1985). Parasitising membranous wings can reduce the flight activity of hosts, so these parasites prefer to parasitise water beetle species associated with permanent waters that do not fly very often (Lanciani 1970b). Those water mite species that rely on their hosts for dispersal seem to avoid parasitising

membranous wings. These attach themselves to sites such as the ventrites of a host, and will have less negative effects on the flight activity of their hosts (Lanciani 1970b; Smith & Oliver 1986).

Having parasites, for sure, is very unhealthy to their hosts. Water mite parasitism is known to reduce body condition of their hosts. Fairn *et al*. (2008) found that the lengths of the elytra were negatively correlated with the mite abundance on the hosts. A similar correlation was also found in the wing lengths of other host insects, such as damselflies (Rolff *et al*. 2000). Water mite parasitism can lower egg production of Diptera and Hemiptera (Smith *et al*. 2009), but there seems to be no study on water beetle fertility yet.

Parasitism of water mites on water beetles can be sex-biased, although researchers have recorded contradictory observations regarding this issue. For example, Fairn *et al*. (2008) reported that male Gyrinidae were more exposed to water mite larvae than females, while Aykut and Esen (2017) reported more females were infected than males of diving beetles. There have been various opinions about sex-biased parasitism of water mites, but no clear pattern has yet been found.

AIKEN R B 1985. Attachment sites, phenology, and growth of larvae of *Eylais* sp. (Acari) on *Dytiscus alaskanus* J. Balfour-Browne (Coleoptera: Dytiscidae). *Canadian Journal of Zoology* **63** 267-271.

ARJOMANDI E, ZAWAL A, HAJIQANBAR H, ILIP E & SZENEJKO M 2019. New record of a parasitising species of *Hydrachna* (Acari, Hydrachnidia) on water beetles *Eretes griseus* (Fabricius, 1781) (Coleoptera, Dytiscidae, Dytiscinae, Eretini). *ZooKeys* **865** 31.

AYKUT M & ESEN Y 2017. Parasitism of diving beetles (Coleoptera: Dytiscidae) by larvae of the water mite *Acherontacarus rutilans* (Hydrachnidiae, Acari) in Diyarbakır Province, Turkey. *International Journal of Acarology* **43** 347-350.

BÖTTGER K 1976. Types of parasitism by larvae of water mites (Acari: Hydrachnellae). *Freshwater Biology* **6** 497-500.

BRUMPT E 1929. Fréquence du parasitisme d'*Hydrachna processifera* sur le *Dytiscus marginalis* en Normandie**.** *Annales de Parasitologie* **7** 290-302.

FAIRN E R, SCHULTE-HOSTEDDE A I & ALARIE Y 2008. Water mite parasitism is associated with body condition and sex of the whirligig beetle *Dineutus nigrior* (Coleoptera: Gyrinidae). *Ecoscience* **15** 327-331.

LANCIANI C A 1970a. New species of *Eylais* (Acari: Eylaidae) parasitic on aquatic Coleoptera. *Transactions of the American Microscopical Society* **89** 169-188.

LANCIANI C A 1970b. Resource partitioning in species of the water mite genus *Eylais*. *Ecology* ***51*** 338-342.

MORTAZAVI A, HAJIQANBAR H & LINDQUIST E E 2018. A new family of mites (Acari: Prostigmata: Raphignathina), highly specialized subelytral parasites of dytiscid water beetles (Coleoptera: Dytiscidae: Dytiscinae). *Zoological Journal of the Linnean Society* **184** 695-749.

ROLFF J, ANTVOGEL H & SCHRIMPF I 2000. No correlation between ectoparasitism and male mating success in a damselfly: why parasite behavior matters. *Journal of Insect Behavior* **13** 563-571.

SMITH I M, COOK D R & SMITH B P 2009. Water mites (Hydrachnidiae) and other arachnids. pp. 485-586 in: J.H. Thorp & A.P. Covich (eds) *Ecology and classification of North American freshwater invertebrates*. 3rd edition. Amsterdam: Academic Press.

SMITH I M & OLIVER D R 1986. Review of parasitic associations of larval water mites (Acari: Parasitengona: Hydrachnida) with insect hosts. *The Canadian Entomologist* **118** 407-472.
ZAWAL A 2003. The role of insects in the dispersion of water mites. *Acta Biologica Universitatis Daugavpiliensis* **3** 9-14.
ANATOLY MIKHALTSOV, 29.11.2015. Водяной клещ in Wikimedia Commons. https://commons.wikimedia.org/wiki/File: Водяной клещ.jpg

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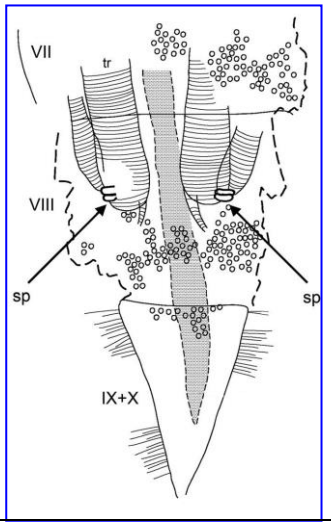
SWIMMING IN CANALS

Laboratory experiments were performed with five species of frog – *Pelophylax nigromaculatus* (Hallowell), *P. porosus* (Cope), *Glandirana rugosa* (Temminck &Schlegel), *Fejervarya kawmurai* Djong *et al*., and *Hyla japonica* Günther, all collected from the Kinki region of Japan. For anyone who doesn't know *Regimbartia attenuata* (Fab.), this hydrophilid is rather like a small *Hydrobius* flattened from side to side and capable of swimming like *Berosus*. *Regimbartia* adults survived passage through all five frog species, coming out head first within 6 hours. It is presumed that they had to stimulate the frogs to open the vent to permit escape. In contrast, when *Regimbartia* had their legs fixed down with wax (beetles with "waxed legs" would be quite different!) and were then fed to frogs they all died and were excreted 38 hours or more later. *Enochrus japonicus* (Sharp), which cannot swim, suffered a similar fate (not the waxing!).

SUGIURA S 2020. Active escape of prey from predator vent via the digestive tract. *Current Biology* **30** R867-R868 plus Supplemental Information.

TRIASSIC LARVA



The first "Sialidae-type" larva was described from the Middle Permian (*Kargalarva permosialis* Prokin *et al*. – see ***Latissimus* 44** 19). This one, from the Upper Triassic, is more clearly interpreted as the aquatic larva of a beetle, with tracheal gills. It has what is probably a character unique to beetles, the "annular-biforous" spiracles (sp on the figure). These are known in some Myxophaga, in Haliplidae and in basal polyphagan families.

PROKIN A A & BASHKUEV A S 2020. *Trialarva coburgensis* gen. et sp. nov., a remarkable fossil holometabolan larva (Insecta: Coleoptera) from the Triassic in Germany. *Paläontologische Zeitschrift* doi.org/10.1007/s12542-020-00527-6 6 pp.

GREENLAND SUBFOSSIL HISTORY

Deposits recently exposed by coastal erosion have revealed relatively little sign of human impact on material from the 14th to 17th Centuries, this perhaps being associated with the Little Ice Age. The water beetle record is clear, Mingook (*Colymbetes dolabratus* (Paykull) and the Children of Mingook (*Hydroporus morio* Aubé) are the only species represented, as in earlier work (e.g. Böcher *et al*. 2012 – see ***Latissimus* 34** 22), and in the present day.

PANAGIOTAKOPULU E, SCHOFIELD J E, VICKERS K, EDWARDS K J & BUCKLAND P C 2020. Thule Inuit environmental impacts on Kangeq, southwest Greenland. *Quaternary International* **549** 176-190.