

Occurrence of *Ammothea hilgendorfi* (Böhm, 1879) a pycnogonid from the north Pacific, in Étél river

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Abstract

The pycnogonid *Ammothea hilgendorfi* from the north Pacific was introduced accidentally to Europe where it is known from Southern England, Netherlands and the Venice lagoon. It was collected in rivière d'Été, South Brittany (47°40'N 3°11'W) where it forms a locally dense population. This species was actively reproducing in late September and mid November. It is carnivorous, may be a scavenger and manifests a gregarious behaviour at least at low tide. It is likely to have a significant impact on its host environment due to its high density population. Its probable further spreading deserves to be monitored.

Keywords: alien species; *Ammothea hilgendorfi*; Étél river; pycnogonids

Présence d'*Ammothea hilgendorfi*, un pycnogonide originaire du Pacifique nord, en rivière d'Été

Résumé

Le pycnogonide *Ammothea hilgendorfi*, originaire du Pacifique nord et introduit accidentellement en Europe où il est connu du sud de l'Angleterre, des Pays-Bas et de la lagune de Venise, a été récolté en rivière

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d'Étel, Bretagne sud (47°40'N 3°11'W) où il constitue une population localement dense. L'animal est observé en reproduction fin septembre et à la mi-novembre. Il est carnivore, voire charognard et manifeste un comportement grégaire au moins à basse mer. Cette espèce est susceptible d'avoir un impact non négligeable sur son milieu d'accueil et son expansion probable mérite d'être suivie.

Mots-clés : *Ammothea hilgendorfi* ; espèce introduite ; pycnogonides ; rivière d'Étel

Introduction

On September 28th 2019 a team of seven members of “Bretagne Vivante” (environmental protection association) carried out a preliminary inventory of the flora and fauna at Iniz er Mor islet in the Étel river (47°40'N 3°11'W), southern Brittany (Figure 1). The land part of the islet, managed by the association, is protected for its natural habitats (French arrêté de protection de biotope) particularly for accommodating a nesting tern colony. During this survey a species new to French fauna, the pycnogonid *Ammothea hilgendorfi* (Böhm, 1879) was collected. Later, on November the 17th, a search on the southern shore of Tog Ru, an islet located nearer to the outer mouth of the river, resulted in an abundant harvest of the same species (around 70 individuals).

Description of the sampling site

The Étel river is a marine ria of the southern coast of Brittany penetrating 12 km inland. The sites of Iniz er Mor and Tog Ru lie 6.6 km and 3.9 km respectively, north to its mouth.

Relatively strong tidal streams run to and fro along the river, however its shores may be considered as sheltered owing to the narrow fetch they are faced to in their almost landlocked situation.

North to Pont-Lorois, the shore is mostly muddy although the two sampled sites are dominated by rocky habitats including pebbles and boulders, the latter being more abundant at Tog Ru.

The mediolittoral zone is covered by the usual fucal belts of Brittany, whose extent however is seriously reduced by the grazing of limpets (*Patella vulgata* Linnaeus, 1758) on the eastern side of Iniz er Mor.

Many oyster farms, mainly devoted to the Pacific oyster *Magallana* (= *Crassostrea*) *gigas* (Thunberg, 1793) culture occupy the lower part of the mediolittoral and the upper part of the infralittoral zones.

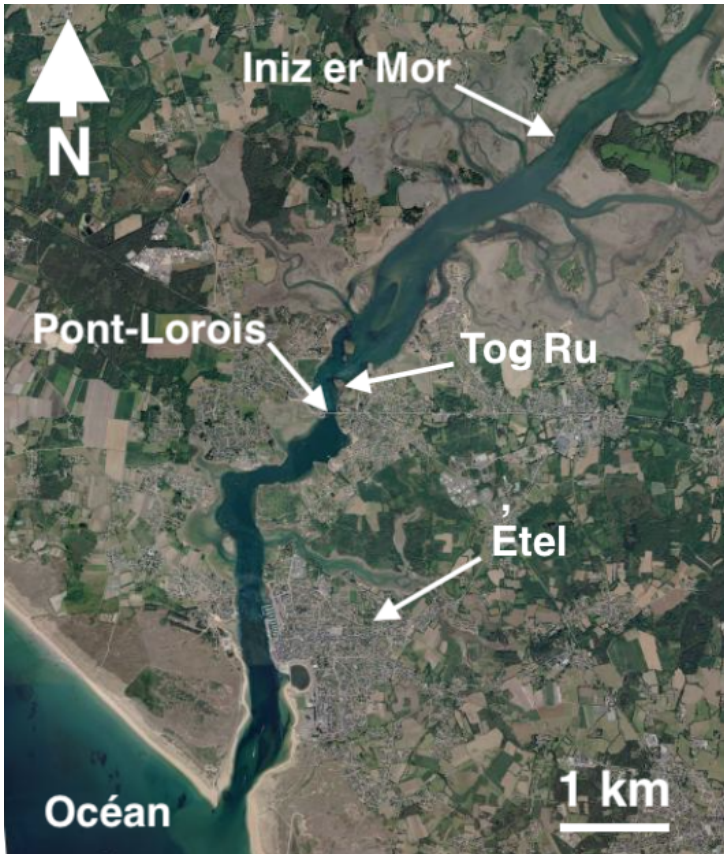


Figure 1: Aerial view of the Étel river near its mouth and position of the places referred to in the text. © IGN 2016, <https://www.geoportail.gouv.fr>.

Salinity as measured near Pont-Lorois from 2009 to 2018 by Ifremer (<https://wwz.ifremer.fr/surval>), has a mean value of 32.5 (maximum: 35.8; minimum: 22.7; $n = 134$; $\sigma = 2.34$), thus appearing to be relatively stable and within the characteristic range of marine waters.

The intertidal fauna is relatively rich at Tog Ru (132 species recorded in 2011 during a single low tide), on the contrary it appears impoverished at Iniz er Mor (only 81 species collected in September 2019), probably as a consequence of the algal belts regression and of the more confined environment of this site.

Ammothea hilgendorfi

Ammothea hilgendorfi is native to the west and east coasts of the North Pacific. It was introduced to Europe in the seventies and first found in UK on a Dorset (southern England) shore in 1978 (Bamber, 1985). It was more recently observed on the coast of the North Sea (Essex) (Bamber, 2012) and has also been recorded in the Venice lagoon (Krapp & Sconfiatti, 1983) and on the coasts of the Netherlands in the Oosterschelde (Faasse, 2013) .

Morphological criteria for identification

The identification of *A. hilgendorfi* from Iniz er Mor is based on the description by Utinomi (1959, as *Lecythorhynchus hilgendorfi* (Böhm)) from Japanese samples as well as on morphological characters provided by the authors who identified specimens from Europe (see above) and particularly Bamber (2010) .

At Iniz er Mor two individuals were directly collected in the field and a third one was found later in a cluster of ascidians [*Molgula socialis* Alder, 1863 and *Polycarpa violacea* (Alder, 1863)] brought to lab for identification.

Amongst these, two individuals were immature whilst the third was an egg-ball carrying male, i.e. an adult. The latter being the specimen our description is mainly based on.

This adult male (see figure 2A) measures from tip to tip of its outstretched legs 20 mm, which corresponds to the maximum size reported by Faasse (2013). The literature does not mention any significant size differences between sexes. This seems to be corroborated in a Tog Ru sample where size ranges from 20 to 24 mm for males and from 22 to 23 mm for females (n = 9 for each sex). Note that the measurements are somehow approximate, depending on our ability to correctly extend the animal while keeping it into focus, which proved difficult. This is why size ranges instead of mean lengths are given.

The proboscis is approximately 1.8 mm in length, distally swollen, and obliquely positioned relative to the trunk, which is about 1.5 mm long (Figure 2A). The trunk segments are well separated, the first three having a transverse dorsal ridge on their posterior region (Figure 2B) as mentioned by Bamber (1985, 2010) and Faasse (2013). The short abdomen (about 0.5 mm) is almost at right angle upward to the trunk.

The chelifores (Figure 2A) are simple rounded tubercles, some 0.13 mm in length.

The palps whose proximal articles are applied against the proboscis are 9-articled (Figure 2C), the fifth one exhibits a setose flattened protuberance, as figured by Utinomi (1959), Krapp & Sconfiatti (1983) and Bamber (2010). Segments 2 and 4 are longer than the others reaching 0.84 mm and 0.88 mm respectively. These measures are close to those deduced from the figures of Utinomi (1959) (0.90 mm and 0.85 mm) and of Krapp & Sconfiatti (1983) (0.85 mm and 0.81 mm).

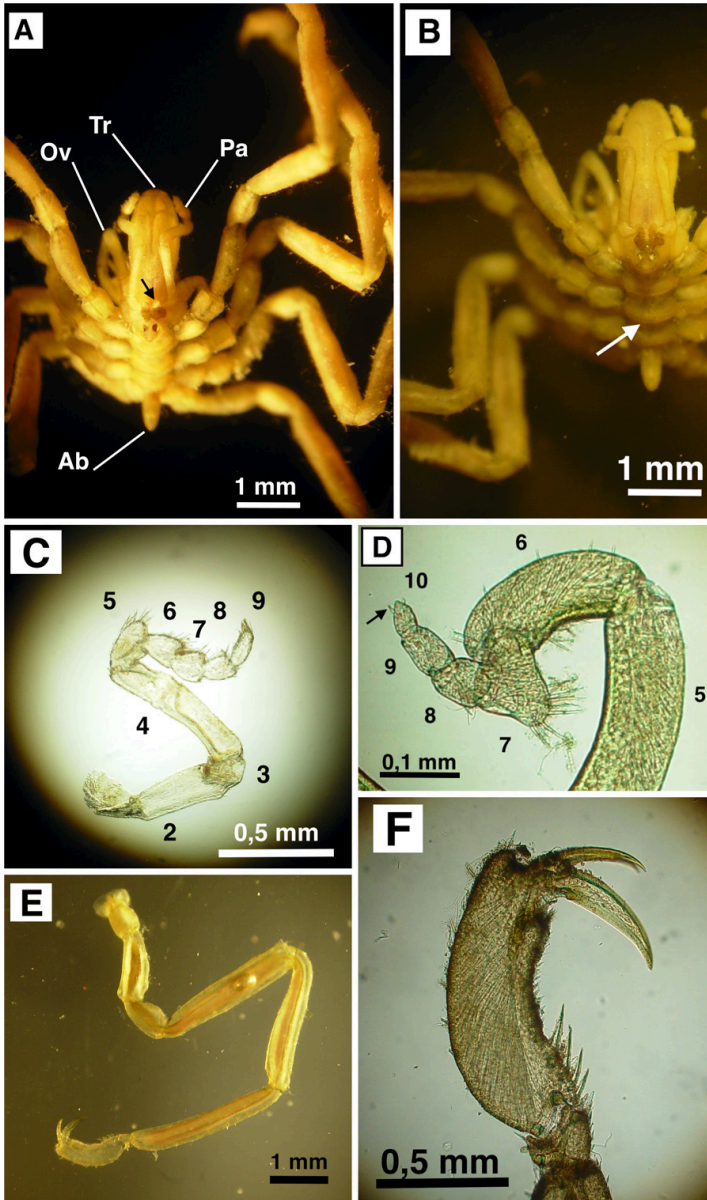


Figure 2: *Ammothea hilgendorfi* (Böhm, 1879), male collected at Iniz er Mor. A. Dorsal view. Ab, abdomen; Ov, Ovipiger; Pa, Palp; Tr, Proboscis. The black arrow points to the right chelifer. B. Oblique dorsal view highlighting the transverse dorsal ridges (arrow). C. Palp. The numbers correspond to the rank of the articles. The proximal part of the second article is crushed. D. Ovipiger. The numbers correspond to the rank of the articles. The arrow points to the compound setae of the 10th article. E. Third leg. F. Propodus and claws. The two accessory claws seem separated only at their tips.

The ovigers (Figure 2D) are 10-articled. On article 7, an apophysis clearly figured by Bamber (2010) is adorned with 12 stiff setae. As mentioned by this author the three distal articles bear two short compound spines (see arrow in figure 2D). Moreover article 8 bears, opposed to these spines, 4 long setae, the same type as those of the 7th.

The legs (Figure 2E) measure about 0.9 mm in length (3rd leg) and are terminated by a large main claw and two accessory claws (Figure 2F) as illustrated by Utinomi (1959), Krapp & Sconfiatti (1983) and Faasse (2013).

So, the main morphological characters are in close accordance with those described in *A. hilgendorfi*, species to which we attribute our specimens.

Colour

The general colouring pattern of *A. hilgendorfi* results from two principal components. On the one hand a more or less dark reddish-brown pigmentation of the tegument as detailed below, on the other hand the digestive tract, of a dark hue, which is visible through the tegument if not concealed by its pigmentation. It appears in legs segments up to the 6th (tibia 2). Furthermore the legs are speckled with white dots, and allow the observation in live of the flow of whitish blood globules as well as, in breeding females, the whitish eggs (Figure 3B).

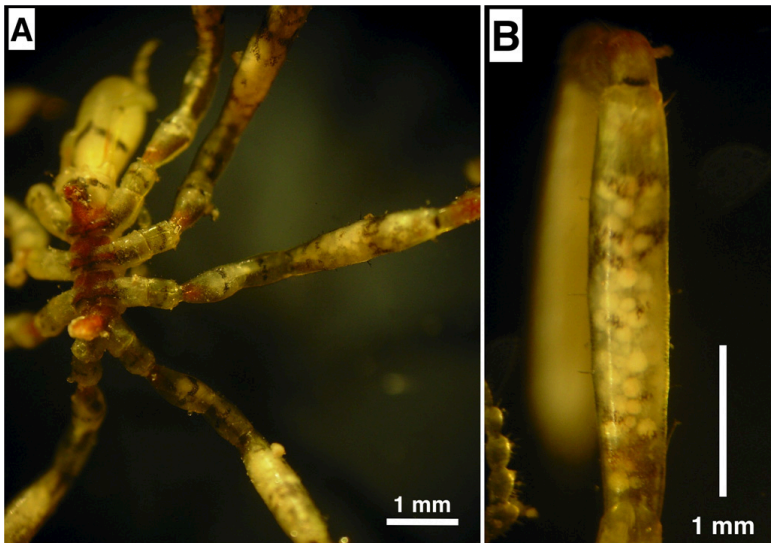


Figure 3: *Ammothera hilgendorfi* (Böhm, 1879) (female). A. Colour pattern. Ovules appear in the femurs. B. Femur letting appear the ovules more clearly. Up, on the tibia 1 a black dot is to be noticed at the joint level.

A nearly black stripe around the proximal third of the proboscis describes a conspicuous inverted V on its dorsal side (Figure 3A). This feature may however be re-

duced and even absent (2 cases observed). The third article of the palp bears a black dot (see figure 3A).

The dorsal side colour of the body, at the exception of the lateral processes, is of a dark reddish-brown that conceals most of the digestive tract. This colour extends almost to the tip of the abdomen. A dark band marks the posterior margin of the three dorsal transverse ridges of the trunk somites while their lateral parts are much clearer.

Each of the three articles of the coxae exhibits a dark ring more obvious on the dorsal side. The colouring of the three following articles (femur, tibia 1, tibia 2) appears more scattered, blotchy and variable. A dark spot is located on the base of the 5th and 6th articles (tibia 1 and tibia 2), otherwise the legs are mottled with white dots. The 6th article is generally weakly coloured. The 8th article (propodus), almost devoid of pigmentation, is very clear, whitish, in live specimens.

Figure 4, taken in the field shows the living appearance of the animal.



Figure 4: *Ammothea hilgendorfi* (Böhm, 1879). Colour pattern on the live and natural conditions (photo: Yves Le Bail).

The above colouring pattern is quite in agreement with that of the californian individuals shown by P.J. Bryant website (<http://nathistoc.bio.uci.edu/Pycnogonida/Ammothea.htm>), as well as with that from the UK (see D. Fenwick's website: http://www.aphotomarine.com/marine_other_sea_spider_ammothera_hilgendorfi.html).

The legs colours of our specimens are less contrasted than those from Faasse's

figure 1, this may be in account with the fact that Faasse's picture was taken after animal death.

In Bamber's figures (1985, 2010) the proboscis V, the palp 4th article dot, the coxae 1 ring are lacking while the legs present large uniformly grey or black patches. These minor differences with the above description may be ascribed to drawing simplifications.

The colouring pattern confirms the attribution of our specimens to the species *A. hilgendorfi* out of morphological characters.

Remarks on the biology of *Ammonothea hilgendorfi*

Habitat

A. hilgendorfi lives on the underside of boulders on the lower part of the *Fucus serratus* Linnaeus, 1753 belt and further down the shore to the infralittoral. Individuals may be found alone although at Tog Ru (Figure 5A–B) most specimens were generally gathered in groups of 10 or more in little hollows at the rock surface or against reliefs formed by oyster shells or polychaete tubes. In this case, they tightly huddle motionless, with the legs intermingled. At first sight the group looks like a heap of vegetal debris. We suppose that such gatherings probably occur only at low tide. *A. hilgendorfi* may reach high densities as we counted some 70 individuals on some 20 square metres.

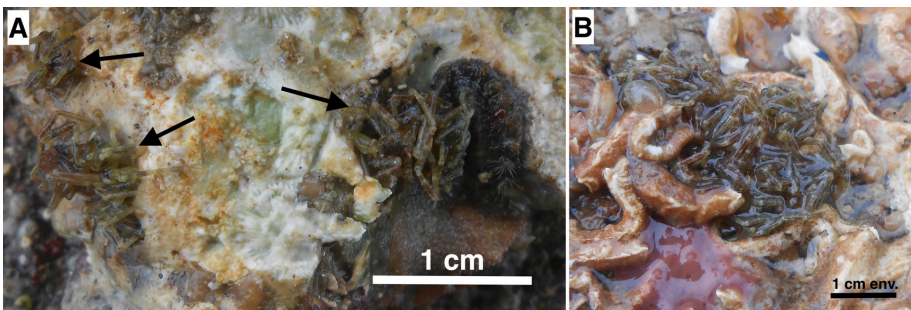


Figure 5: *Ammonothea hilgendorfi* (Böhm, 1879). A and B. Groups on the underside of boulders (arrows in A). B. Approximate scale bar.

Reproduction

In a sample of 55 animals, 26 were males, 25 females while 4 were immature which gives a sex ratio close to 1. The low number of immatures suggests that young animals might somehow be segregated from adults. Indeed, no larva was observed on the rock surface or upon some hydranths of *Clytia hemisphaerica* (Linnaeus, 1767),

a hydroid unwittingly picked up with the pycnogonids. This campanulariid species could be in Europe a convenient host for *A. hilgendorfi* which, according to Russel & Hedgpeth (1990), is parasitic on a hydroid of the same family, *Orthopyxis* (= *Eucopella*) *everta* (Clark, 1876) in California.

Faasse (2013), the only available reproduction reference from Europe, reports the presence of reproductive specimens in late August. Out of 13 males observed the day after their collection at Tog Ru, 4 bore egg-balls on their ovigers while 10 out of 16 females had numerous visible eggs in their femurs (Figure 3A–B). Hence the breeding season was going on in autumn (late September at Iniz ar mor; November at Tog Ru). Brittany shows a mild climate with e.g. seawater temperatures, recorded close to the sampling station (Pont-Lorois), in November, from 2010 to 2018 (see <https://www.ifremer.fr/surval/>) ranging from 10 to 16 °C (mean for 11 data = 12.9 °C, $\sigma = 2.1$). Interestingly, it has to be noticed that out of the 17 males observed after two and a half days of captivity, none bore egg-balls while many exhibited one or two severed ovigers suggesting that eggs and lacking appendage articles had been devoured by their fellows.

Feeding

Pycnogonids diet is rather poorly known (Bamber, 2010). They are generally considered as predators or merely as parasites since their feeding may kill or leave their preys alive. Preys are potentially very diverse, consisting of a wide variety of invertebrate species from sponges to ascidians, but very often of cnidaria (Dietz *et al.*, 2018). In Japan, *A. hilgendorfi* was reported as an ectoparasite on holothurids (Oshima, 1927, quoted by Russel & Hedgpeth, 1990).

We did not observe any specimen acting as a predator in the field at Tog Ru. However, some 4 hours after collecting, one of them was ingesting the naked rear part of an annelid *Spirobranchus* sp. whose tube was broken. The day after, another *Ammonothea* diligently attacked the naked body of the barnacle *Verruca stroemia* (O.F. Müller, 1776). However the meat of the bivalve *Hiatella arctica* (Linnaeus, 1767) fed to a group that had been starved for 3 days did not induce any activity in any specimen that were some 2 centimetres away. However, when the meat was drawn directly into contact with them some individuals applied their proboscis on it and seemed to ingest the food while others stood quiet at first but eventually, after one to two hours, many of them took part to the meal.

Added to the probable cannibalism through egg and appendage consumption mentioned above these observations suggest that *A. hilgendorfi* might be an opportunistic carnivore able to act as a scavenger. Yet, its food preferences have still to be determined.

Behaviour when disturbed

When insistently disturbed *A. hilgendorfi* stops in a characteristic standstill position: the legs coxae are turned down ventrally while the rest of the appendages is raised up dorsally. The femurs then form a conical cage above the body, while the succeeding articles group in a narrow bundle, looking like a club or a lantern handle (Figure 6A).

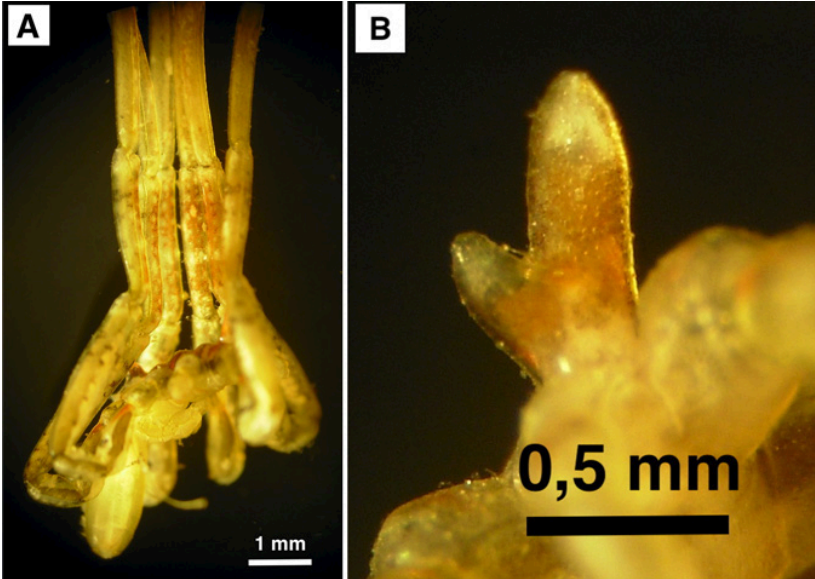


Figure 6: *Ammothea hilgendorfi* (Böhm, 1879). A. Animal with folded appendages. The proboscis appears at the bottom left. B. Abnormally bifurcated abdomen.

As an abnormality let us mention a bifurcated abdomen, of which only one branch seems to be functional (Figure 6B).

Conclusion

It has been hypothesized that *A. hilgendorfi* would have been brought to Europe through commercial shipping (Krapp & Sconfiotti, 1983; Bamber, 1985).

However, Bamber (1985) gives an alternative hypothesis of the way of introduction to English waters via the transportation of Japanese oysters *M. gigas* originating from France where it has been intensively cultured from the 1970's. We believe this is rather unlikely to have happened since, so far, the pycnogonid has not been recorded in any French oyster farming site (notably Étang de Thau, Bassin d'Arcachon, Pertuis Charentais) despite its tendency to form rather dense populations and the fact that these sites are under close surveillance for benthic fauna communities.

According to Faasse (2013) its presence in the Netherlands could result either from intercontinental shipping if it is a primary introduction, or if not, it has probably been introduced through recreational shipping or shellfish transportation.

The origin of the Étél river population is currently unknown. Although unlikely, a primary direct introduction through illegal oyster importation from Japan cannot be excluded. However, considering that the species has been present in Europe for almost 4 decades, together with the unceasing shellfish exchanges between culture basins in France and its neighbouring countries, it is very likely that *A. hilgendorfi* has been introduced either from the Adriatic or the Netherlands through oysters or mussels farming activities. Furthermore, this means we can predict that it will soon be scattered through the same vectors along the coasts of Brittany and France.

The effects of the introduction of *A. hilgendorfi* to a newly colonized environment are still largely to be unveiled. Owing to its relatively small size it could be hypothesized that its effects would be negligible. However such point of view appears rather unreasonable because every organism although being small and apparently harmless can be the vector of viruses, bacteria or protozoan that may potentially bring various diseases to indigenous invertebrate species. Moreover considering the densities observed in Étél river, this small predator might have serious effects on its preys populations, small- or large-sized ones as well, by destroying any life stage i.e. eggs, larvae or juveniles and adults. This could induce negative effects on large populations, on the trophic web and in turn on the whole habitat.

The proliferation observed at Tog Ru may correspond to the boom frequently noticed among newly introduced populations, thus likely to be a transitory situation. However high densities were also observed in the UK by Bamber (2010) as well as in the Netherlands by Faasse (<https://www.nederlandsesoorten.nl/+Ammonothea+hilgendorfi>) which suggests the dense population reported here might be established for a while.

The presence of *A. hilgendorfi* in the Étél river raises many questions. Considering its population density a thorough study of its biology as well as a monitoring of its expansion would be required.

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