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Land flatworms (Tricladida: Geoplanidae) in France and French overseas territories: ten years of research

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ABSTRACT. Since 2013, we have undertaken a detailed study of terrestrial flatworms (Geoplanidae) introduced into mainland France (including Corsica). Around ten species have been listed, mapped, and often characterized molecularly. These species include, in alphabetical order, *Bipalium kewense*, *Caenoplana coerulea*, *Caenoplana decolorata*, *Caenoplana variegata*, *Diversibipalium multilineatum*, *Marionfyfea adventor*, *Obama nungara*, *Parakontikia ventrolineata*, *Platydemus manokwari*, and *Vermiviatum covidum*. Outside of mainland France, we also studied species from the French islands of the Caribbean (Guadeloupe, Martinique), Réunion and Mayotte in the Indian Ocean, as well as New Caledonia, French Polynesia, and Wallis and Futuna in the Pacific. Two new species have been described. The major invasive species in mainland France are *Obama nungara*, present in two thirds of the country, *Caenoplana variegata*, and *Parakontikia ventrolineata* (especially in Brittany). *Bipalium kewense* and *Diversibipalium multilineatum* are mainly present in the southwest region of the French Atlantic coast. The origins of invasive species in France are varied and include Argentina (*Obama nungara*), Australia (*Caenoplana variegata* and *Parakontikia ventrolineata*), and Southeast Asia (Bipaliinae). We have characterized and published the complete mitogenomes of 12 species, with unexpected results, such as the very long cox2 gene in Rhynchodeminae. The phylogenies built on the genes of the mitogenomes generally confirm the previous classifications of the subfamilies of Geoplanidae, and individualize the three subfamilies Rhynchodeminae, Geoplaninae, and Bipaliinae. We emphasize the importance of citizen science for obtaining data, and the importance of good communication with the public to obtain significant engagement towards citizen science.

KEYWORDS. Citizen science, invasive alien species, mitogenome.

INTRODUCTION

In March 2013, a small animal photography enthusiast, Pierre Gros, photographed a land flatworm in his garden. After a few detours through entomology sites, the photo arrived by email to one of us (JLJ). The recipient, a parasitologist specializing in nematodes and monogeneans, had never worked on land flatworms, but by attending international congresses on Platyhelminthes and following a few encounters with local species during a stay in New Caledonia, he was not completely devoid of zoological culture. He did what a researcher should do when faced with an unknown animal: some bibliographic research, identifying competent researchers in the field, and contacting them.

Ten years later, what began as a small burst of personal scientific curiosity has transformed into a set of publications which mean that the land flatworm fauna in France has gone from a virtually virgin subject to one with very significant amounts of data, probably one of the most important for continental Europe. In this adventure, citizen

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science has played a considerable role, making it possible to acquire abundant data on the presence of species, and also specimens. Molecular studies, initially based on Sanger sequencing and then on next-generation sequencing (NGS), made it possible to differentiate species, clarify the genetic structures of populations, and also describe the mitogenomes of Geoplanidae.

In this article, we take stock of this research, recalling the power of citizen science for acquiring data; we compile the results but also highlight the gaps in our knowledge on the subject, and what still needs to be done. The topic of phytosanitary measures to prevent the import of invasive land flatworms has been dealt with elsewhere (Murchie and Justine 2021).

MATERIAL AND METHODS

Although this article is mainly a review based on published information, the maps provided here are new. Maps were produced from the website of the Inventaire National du Patrimoine Naturel (INPN, https://inpn.mnhn.fr/accueil/index?lg=en). We used the data freely available in the Openobs database https://openobs.mnhn.fr/ that currently includes more than 140,000,000 observations. Data on land flatworms, including in Mainland France and all overseas territories, include 2,094 observations (January 5, 2024) and are mainly based on papers published by the present team and citizen science data individually verified by one of us (JLJ) over the last 10 years.

Table 1 provides a list of Geoplanidae species mentioned in this article with full taxon authors. Its purpose is to lighten the text because of the very long list of authorities for some taxa, e.g., *Vermiviatum covidum.*

RESULTS AND DISCUSSION

When we started our work on land flatworms in France, almost nothing was known about invasive species. For example, the only information on the presence of *Bipalium kewense* in gardens in mainland France had been published in a regional mycology journal with confidential distribution (Vivant 2005). Moreover, some species had not even been described, such as *Obama nungara*. An early article, published in 2014, gives an account of the uncertainties we faced at the start of our work (Justine et al. 2014a). Here, we provide a summary of currently available information on the species.

Platydemus manokwari

Platydemus manokwari (Figs 1, 2) was widely known from its invasion of the Pacific islands (Gerlach et al. 2021, Winsor 1983). Because the species is a predator of molluscs,

Table 1. Geoplanidae species mentioned in this article with full taxon authors. The main purpose of this table is to lighten the text because of the very long list of authorities for some taxa; species are in alphabetical order. The main articles on the presence of each species in France and overseas French territories are also indicated.

Taxon and authors	References for taxon	Main references for presence in France of overseas French territories
Australopacifica atrata (Steel, 1897)	Steel (1897)	Not present
Bipalium admarginatum de Beauchamp, 1933	De Beauchamp (1933)	Not present
Bipalium vagum Jones & Sterrer, 2005	Jones and Sterrer (2005)	Justine et al. (2018b)
Bipalium kewense Moseley, 1878	Moseley (1878)	Justine et al. (2018b)
Caenoplana coerulea Moseley, 1877	Moseley (1877)	Justine et al. (2014a), This paper
Caenoplana decolorata Mateos, Jones, Riutort & Álvarez-Presas, 2020	Mateos et al. (2020)	Justine et al. (2020b)
Caenoplana variegata Fletcher & Hamilton, 1888	Fletcher and Hamilton (1888), Jones et al. (2020)	Justine et al. (2014a), This paper
Diversibipalium mayottensis Justine, Gastineau, Gros, Gey, Ruzzier, Charles & Winsor, 2022	Jones and Sluys (2016), Justine et al. (2018b)	Justine et al. (2018b)
Diversibipalium multilineatum (Makino & Shirasawa, 1983) Kubota & Kawakatsu, 2010	Kubota and Kawakatsu (2010), Makino and Shirasawa (1983)	Justine et al. (2018b), Mazza et al. (2016)
Marionfyfea adventor Jones & Sluys, 2016	Jones and Sluys (2016)	Jones and Sluys (2016)
Obama nungara Carbayo, Álvarez-Presas, Jones & Riutort, 2016	Carbayo et al. (2016)	Justine et al. (2020c)
Parakontikia ventrolineata (Dendy, 1892) Winsor, 1991	Dendy (1892), Winsor (1991b)	Justine et al. (2014a), This paper
Platydemus manokwari de Beauchamp, 1963	de Beauchamp (1962)	Justine et al. (2014b, 2015, 2021)
Vermiviatum covidum (Justine, Gastineau, Gros, Gey, Ruzzier, Charles & Winsor, 2022) Solà, Sluys, Riutort & Kawakatsu, 2023	Justine et al. (2022a), Solà et al. (2023)	Justine et al. (2018b, 2022a)

Figures 1–2. *Platydemus manokwari*: (1) Specimen alive collected in a hothouse, Caen, France, dorsal view. (2) Experimental predation on indigenous snail. The prey is the helicid *Eobania vermiculata*, a common snail of the Mediterranean region. Photos by Pierre Gros, from Justine et al. (2014b).

it was deliberately established on various islands to counter another invasion, that of the giant snail *Lissachatina fulica* (Férussac, 1821). We found *Pl. manokwari* in only one place in mainland France, a greenhouse in the Jardin des Plantes in the city of Caen (Justine et al. 2014b). When we published this article in 2014, we considered it possible that the species was spreading in the wild since it had been reported at high altitudes in New Guinea (de Beauchamp 1972, Winsor 1990), at temperatures comparable to those of continental Europe. Ten years later, we can confirm that *Pl. manokwari* has never been found in the wild in mainland France. Nonetheless, thanks to international collaborations, in 2015 we mentioned the presence of the species in new localities, including the first report in continental North America, in Florida (Justine et al. 2015). As of 2023, the species has now largely invaded Florida and even neighboring states in the United States. The species has recently invaded the French Antilles, including the islands of Guadeloupe, Martinique, and Saint Martin (Justine et al. 2021) and we often (2023) receive citizen science reports on its continued presence on these islands. Its presence has also been recorded on many islands in the Pacific, including Wallis and Futuna, and on several islands in French Polynesia (Gerlach et al. 2021).

We also studied the genetic structure of *Pl. manokwari* using specimens from different localities around the world (Justine et al. 2015). We have not examined specimens from Papua New Guinea, its place of origin (or, at least, its type locality), but we have had specimens from the relatively nearby Solomon Islands. By studying the cox1 gene, we showed that there are two populations. Both are present on the Solomon Islands, therefore close to the species' place of origin. One of the populations only invaded Australia, while the other population invaded all other localities (Justine et al. 2015).

The complete mitogenome has been published for *Pl. manokwari* (Gastineau et al. 2020), the first species for which we observed an unusual length of the cox2 gene, subsequently confirmed in other Rhynchodeminae (see later paragraph on long cox2).

Obama nungara

We received citizen science reports of *O. nungara* (Figs 3–7) as early as April 2013 in France. It is one of the two species that Pierre Gros found in his garden at the very beginning of our study. At that time, it was impossible to correctly identify the species, since it was only described in 2016 (Carbayo et al. 2016), after several years of taxonomic confusion (Lago-Barcia et al. 2015). In our 2020 article, we described how *O. nungara* is now the most abundant land flatworm species in mainland France (including Corsica) (Fig. 5), both in terms of presence (72 departments out of the 95 departments), and abundance (hundreds to thousands of individuals in a single garden) (Justine et al. 2020c).

We showed through genetic analysis of the cox1 gene that the specimens found in France were close to a population found in Argentina, but not to the population found in Brazil (Justine et al. 2020c) (Fig. 6).

The situation in 2023 is similar, and we continue to record information on the presence of the species. However, some citizen science reports mention the disappearance of the species from certain gardens where it was abundant, an interesting fact that will deserve more attention in coming years.

Figures 3–4. *Obama nungara*: (3) Alive, dorsal view. This specimen shows pronounced dorsal 'tiger stripes'. Specimen from Cagnes-sur-Mer, Alpes-Maritimes. (4) Dark form, feeding on an earthworm. The everted pharynx can be clearly seen partly enveloping the head of the earthworm (unidentified species). Specimen MNHN JL092 from Montauban, Tarn-et-Garonne. Photos by Pierre Gros, from Justine et al. (2020c).

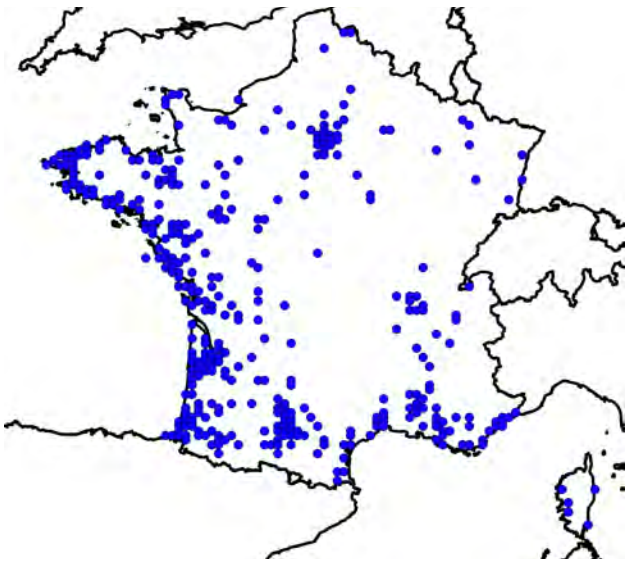


Figure 5. Map of occurrence of *Obama nungara* in mainland France including Corsica. Based on 886 observations in the Openobs database.

Outside of France, *O. nungara* is now reported in many other European countries (Čapka and Čejka 2021, Justine et al. 2020c, Mori et al. 2023). While we wrote in 2020 that the species had not been recorded in Germany based on a recent review (Sluys 2019), nor any country east of Germany, we now have unpublished records from this country. The species therefore seems to be progressing easterly.

Outside of Europe, we have also reported the presence of the species on Reunion Island, an island close to Africa in the Indian Ocean. This was the first record of the species for Africa, although no records are currently available for continental Africa (Justine et al. 2022b). A modelling study at the local scale of Reunion Island showed that the species is limited to an area halfway up the slopes of this island with pronounced relief (Fig. 7). Due to the numerous commercial exchanges between mainland France and Reunion Island, we put forward the hypothesis, supported by a genetic analysis, that the population of Réunion actually came from mainland France, and most likely not from the species' region of origin in South America (Fig. 6).

Modelling studies have shown that the global distribution area of *O. nungara* could become much wider in the years to come (Fourcade 2021).

Importantly, we have collaborated on metabarcoding work on the intestinal contents of *O. nungara* in France which showed that the species consumes a significant number of earthworm species (Roy et al. 2022). A surprising result is that the species consumes deep-dwelling earthworms (endogeic), whereas *O. nungara* is, in principle, a ground surface species. However, we know that the species also consumes molluscs (Boll and Leal-Zanchet 2016) and we have local observation that it prey on slugs and snails, but the metabarcoding analysis concerning molluscs has yet to be completed.

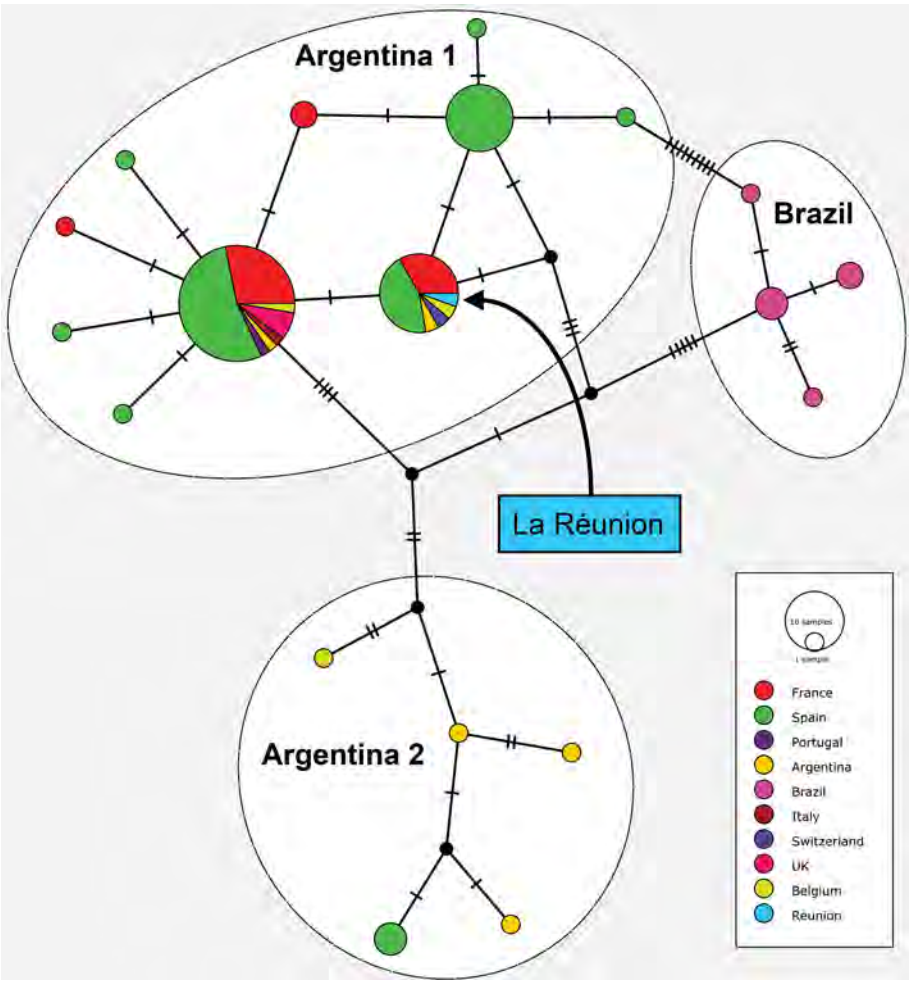


Figure 6. *Obama nungara*, haplotype network. There are three populations, "Argentina 1", "Argentina 2", and "Brazil". Specimens from mainland France and Reunion are similar to a population from Argentina. The network was obtained by using a matrix made public (Justine et al. 2020c) and adding a single sequence, from the specimen MNHN JL449 from Reunion. From Justine et al. (2022b).

Large-size species within the Bipaliinae

The Bipaliinae, or hammerhead flatworms, include very large species, such as *Bipalium nobile* Kawakatsu & Makino, 1982, which can reach a meter in length (not yet found outside Southeast Asia) and which are therefore very spectacular. These giant species are easily identified by reporting citizens. They also greatly inspire journalists in search of captivating content and whistle-blowers on social media networks. Two large species of Bipaliinae have been found in France: *Bipalium kewense* and *Diversibipalium multilineatum*. These species commonly reach 20 cm in length, and sometimes more.

Bipalium kewense

Bipalium kewense (Figs 8–10) is well known as a species that has invaded most tropical or subtropical regions of the world, particularly through plant transport (Winsor 1983), probably including, in the early stages, "Ward's Boxes" used to transport exotic plants (Keogh 2020). For *B. kewense*, we have received two types of reports for mainland France: a few reports in greenhouses, which have no biogeographical value, and to our surprise numerous reports in open environments, within gardens. The citizen science reports spanned around 20 years, the most emblematic being from an individual who kept an old VHS tape showing the family being

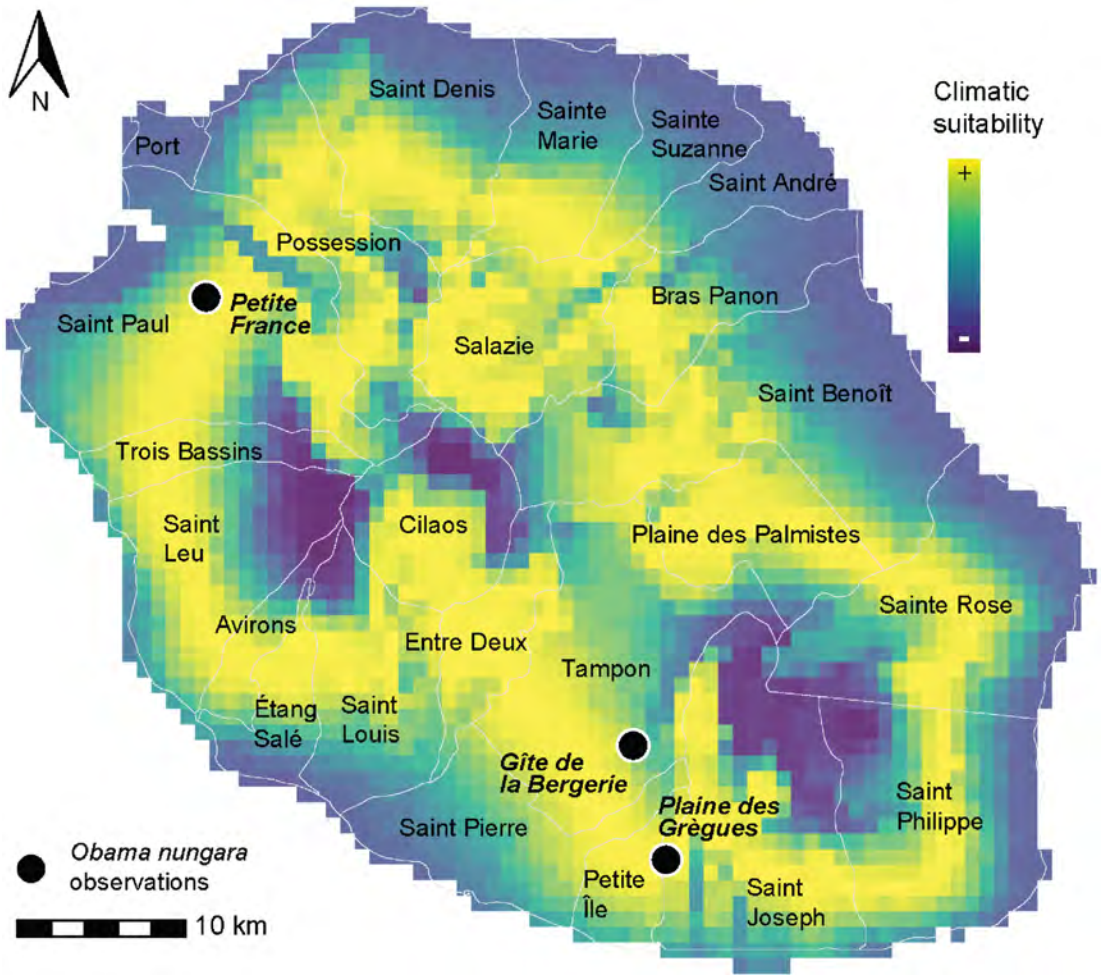


Figure 7. Climatic suitability of *Obama nungara* on Reunion Island, Indian Ocean. The three localities where the specimens were found (Petite France, Plaine des Grègues, and Gîte de la Bergerie) are indicated. From Justine et al. (2022b).

surprised by the presence of a large worm in their garden (Justine et al. 2018b). Reports in gardens are restricted to a small coastal strip along the Mediterranean coast and to a wider area along the Atlantic coast that corresponds to the department of Pyrénées-Atlantiques (Fig. 10). These zones correspond to the hottest regions of mainland France and, for the Pyrénées-Atlantiques, to a warm region but where summer is never completely dry. Citizen science accounts report that in order to escape the cold in winter, this species buries itself up to twenty centimeters deep in the soil. Outside of mainland France, *B. kewense* is also known from the French Caribbean (Guadeloupe, Martinique, and Saint Martin), French Guiana, Reunion Island, and French Polynesia (Justine et al. 2018b), regions whose climate better corresponds to its area of origin in Southeast Asia than to mainland France. New records are regularly published from various tropical and semitropical countries (Agnolin et al. 2019, Borge Medina and Nuñez Martinez 2021, de Luna et al. 2022, Morffe et al. 2016, Mori et al. 2023, Rodríguez-Cabrera and Torres 2019).

Genetic studies on *B. kewense* showed that specimens collected on several continents had exactly the same cox1 sequence (Justine et al. 2018b). This suggests that all the collected individuals, which reproduce asexually and have no sexual organs, are in fact a clone, or, in other words, that a single individual has invaded several continents. However, our studies were limited to a single gene. *Bipalium kewense* is also the first species for which we obtained a complete mitogenome (Gastineau et al. 2019) and, as such, was the starting point for our genomic investigations on the Geoplanidae.

Figures 8–9. *Bipalium kewense*: (8) Alive, general morphology. Dorsal aspect of the planarian with a partial view of the ventral surface. (9) Predation on earthworm. The flatworm initiates here the process of 'capping' the anterior end of the earthworm. Photo by Pierre Gros, from Justine et al. (2018b).

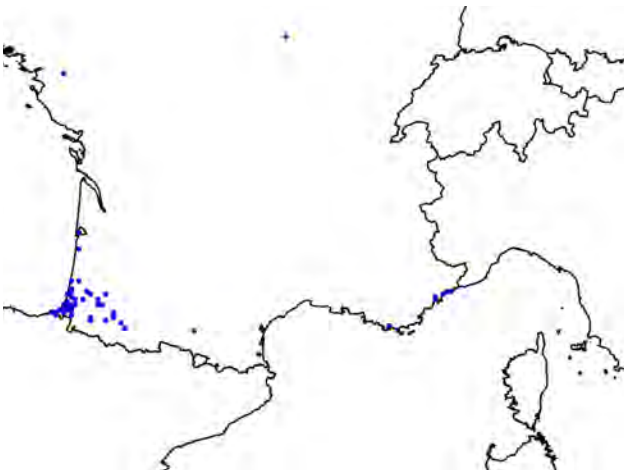


Figure 10. Map of occurrence of *Bipalium kewense* in mainland France including Corsica. Based on 110 observations in the Openobs database.

Diversibipalium multilineatum

Diversibipalium multilineatum (Figs 11–13) is a species that closely resembles *B. kewense* in size, general appearance, and distribution. The species is, however, easily distinguished from the other by its coloring pattern on a good photograph, particularly the appearance of the head (Justine et al. 2018b). This species is slightly less commonly found than *B. kewense* (Fig. 13). In Europe, it has been reported in various countries, including the Netherlands (de Waart 2022), Switzerland (Justine et al. 2018b), Croatia and Slovenia (Mori et al. 2023), and Italy (Dorigo et al. 2020, Mazza et al. 2016, Novarini and Lebech Nässling Iversen 2020). Recent reports on iNaturalist seem to show that it is found increasingly often in the United States (in addition to *B. kewense*, the presence of which has been known for a long time). In contrast to the cosmopolitan species *B. kewense*, there are no mentions of the species in any of the overseas French territories. We have described the mitogenome of this species, but it is the only one for which we have not been able to circularize the mitogenome (Justine et al. 2022a).

For the two species *B. kewense* and *D. multilineatum*, our modelling study shows that they could invade much of Europe, including the North, under the different hypotheses of global warming (Fourcade et al. 2022b). The distribution models predicted suitable habitats for five species of potentially invasive bipaliine in the same region of South America, corresponding to the River Plate basin (covering Uruguay, north-eastern Argentina, south-eastern Paraguay and southern Brazil) and partly expanding through parts of the Atlantic Forest. These regions are well known to host a great diversity of land planarians (Álvarez-Presas et al. 2011, Carbayo et al. 2002, Sluys 1999), and an invasion by bipaliines could be a problem for the local biodiversity of Geoplaninae due to competition and predation.

Bipalium admarginatum

Thanks to a collection by an amateur naturalist, *Bipalium admarginatum* was found 95 years after its description (De Beauchamp 1933) on an island off the coast of the Malaysian peninsula. We have described its mitogenome and clarified its phylogenetic position (Soo et al. 2023). So far, there are no mentions of the species in the literature outside Malaysia.

Figures 11–12. *Diversibipalium multilineatum*: (11) Alive, head. (12) Ventral headplate morphology. Note that the animal seems "menacing"; this photograph had success in the media. Photo by Pierre Gros, from Justine et al. (2018b).

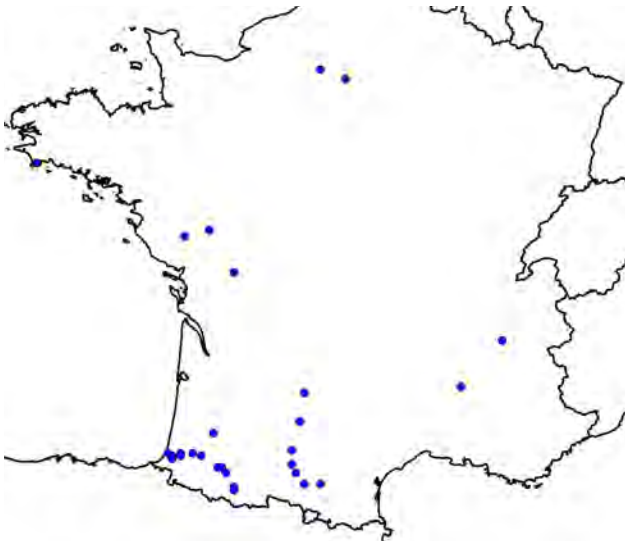


Figure 13. Map of occurrence of *Diversibipalium multilineatum* in mainland France including Corsica. Based on 42 observations in the Openobs database.

Small-size species within the Bipaliinae

Apart from the "giants" mentioned above, we have worked on several species of small Bipaliinae (less than 5 cm).

Bipalium vagum

Bipalium vagum (Fig. 14) is a widespread species, occurring in many subtropical and tropical regions. It has been found on most of the islands in the French West Indies (Martinique, Guadeloupe, and Saint Barthélemy) as well as French Guiana and Reunion Island in the Indian Ocean (Justine et al. 2018b). Other islands in the Caribbean region have also been invaded (Brown et al. 2022). The species was recently reported in Italy (Mori et al. 2022a) and it is not impossible that it has already invaded the warmest parts of Europe (Spain and the South of France). Modelling studies show that this species could invade large parts of Europe under different hypotheses of global warming (Fourcade et al. 2022b). The species consumes molluscs.

Figure 14. *Bipalium vagum*, alive, specimen from French Guiana. Photo by Sébastien Sant, from Justine et al. (2018b).

Vermiviatum covidum

Vermiviatum covidum (Figs 15, 16) was first reported under the name *Diversibipalium* sp. "black" in 2018 (Justine et al. 2018b), then described in 2022 as a member of *Hum-*

Figures 15–16. *Vermiviatum covidum*, alive, specimen from Italy. Note the "menacing" attitude of the individual with raised anterior end; this image had high impact in the media. Photo by Pierre Gros, from Justine et al. (2022a).

bertium Ogren & Sluys 2001 as *H. covidum* (Justine et al. 2022a), then transferred to the new genus *Vermiviatum* in 2023 (Solà et al. 2023). *Vermiviatum covidum* was formally described from specimens collected in Northern Italy and France, in the Pyrénées-Atlantiques mentioned above, which has a climate very favorable to terrestrial Platyhelminthes. In a field in Italy, the species appeared to be swarming, but only one outbreak was spotted; the species can therefore be considered rare, but as it is small and black, it is possible that it escapes most inattentive observers. Since our 2022 article, only one other report has been published, in Italy (Mori et al. 2022a). The species consumes small molluscs, as shown by our study on the DNA of its prey (Justine et al. 2022a), but this information is limited and deserves to be expanded. We described the mitogenome of two individuals of this species, one from Italy and one from France; the mitogenomes showed minor differences, consistent with intraspecific differences (Justine et al. 2022a). With *O. nungara*, this is the only geoplanid species for which the mitogenome was described in two populations.

Diversibipalium mayottensis

Diversibipalium mayottensis (Fig. 17) was formally described from a few specimens found in Mayotte, a French island in the Indian Ocean (Justine et al. 2022a); it was recorded before under the name *Diversibipalium* sp. "blue" (Justine et al. 2018b). The species is characterized by a very particular blue-green coloring pattern, but we were unable to carry out a histological study due to lack of specimens. Our molecular studies place this species as a sister group to all other Bipaliinae (Justine et al. 2018b) but this was not confirmed in another study based on different markers (Solà et al. 2023). As Mayotte is geologically a small island of relatively recent origin, it is likely that the true origin of the species is elsewhere. Madagascar, which is close to Mayotte, is a possibility. Studies of the Bipaliinae of Madagascar should be undertaken to find the species, or close species. The position as sister group to the other Bipaliinae strongly suggests creating a new genus for *D. mayottensis*; in the absence of data on the reproductive system, this was not proposed (Justine et al. 2022a).

Figure 17. *Diversibipalium mayottensis*, alive. Specimen MNHN JL282 from Mayotte, Indian Ocean, dorsal aspect. Photo by Laurent Charles. From Justine et al. (2018b).

Bipalium adventitium

Bipalium adventitium is a species that was only known from the United States (Ducey and Noce 1998), but we reported it from Montréal, Quebec, Canada which was its most northerly record (Justine et al. 2019). The species is obviously of Asian origin but has until now never been found in Asia. Due to its ability to live in very cold climates in winter, this species has great potential to invade northern Europe (Fourcade et al. 2022b), where it has not yet been reported. We have described the complete mitogenome of this species (Justine et al. 2022a).

Species of *Caenoplana*

We have received reports for several species (or species complexes) belonging to the genus *Caenoplana* in mainland France.

Caenoplana variegata

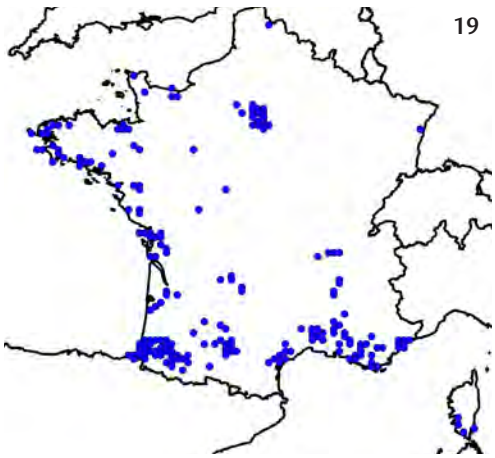
Caenoplana variegata (Figs 18, 19) is the first species spotted by Pierre Gros in his garden in 2013. While we treated the first specimen as a unique treasure, citizen science studies have later shown, ironically, that this species is present in around 40 of the 96 departments of mainland France. It has also been reported in other European countries (Dorigo et al. 2020, Jones et al. 2020, Mori et al. 2023, Thunnissen et al. 2022, Vardinoyannis and Alexandrakis 2019). We briefly mentioned the species in an article (Justine et al. 2014a), but have not yet published detailed results. The species has often been referred to in the literature as *Caenoplana bicolor*, but a 2020 article considers this to be a junior synonym of *Caenoplana variegata* (Jones et al. 2020). Interestingly, in 2023 there were many more reports of this species in mainland France than in previous years, which could suggest that the species is expanding (unpublished observations). The species consumes woodlice and other terrestrial arthropods. We have received photographs showing predation by this species of large arthropod species, including large spiders.

Caenoplana coerulea

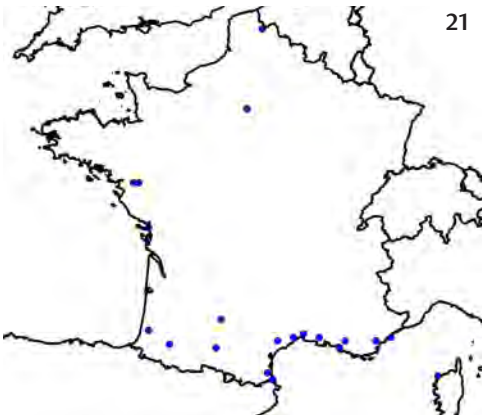
Caenoplana coerulea (Figs 20, 21) is present in some localities in mainland France, but can be considered rare. *Caenoplana coerulea* is apparently a species complex (Álvarez-Presas et al. 2014). Mori et al. (2023), considering that it is impossible to differentiate the species without a molecular analysis, listed their findings as "*C. coerulea/decolorata*" (Mori et al. 2023). The species has been recorded in various locations in Europe and the world (Breugelmans et al. 2012, Luis-Negrete et al. 2011, Mori et al. 2023, Suárez et al. 2018). We have molecular results on a number of individuals that are not yet published.

Caenoplana decolorata

Caenoplana decolorata is a species recently described in Spain (Mateos et al. 2020). It resembles *C. coerulea* morphologically; among the cox1 sequences that we had assigned to *C. coerulea*, we were able to identify a sequence that was identical to that of *C. decolorata*, and we therefore reported the presence of this species in France (Justine et al. 2020b). So far, the original description and our article constitute the only two known reports of this species.



Figures 18–19. *Caenoplana variegata*: (18) Alive, specimen from mainland France. Specimen MNHN JL144 from La Plaine-Saint-Denis. The head is on the left size. Photo by Jean-Lou Justine, original. (19) Map of occurrence in mainland France including Corsica. Based on 404 observations in the Openobs database.



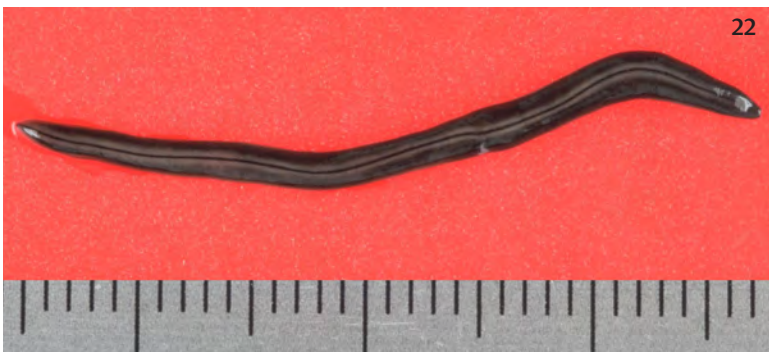
Figures 20–21. *Caenoplana coerulea*: (20) Alive, specimen from Morton National Park, NSW Australia. Photo by John Tann, from Wikimedia, CC-BY license, original file: https://commons.wikimedia.org/wiki/File:Blue_garden_flatworm_(8253041759).jpg. (21) Map of occurrence in mainland France including Corsica. Based on 27 observations in the Openobs database.

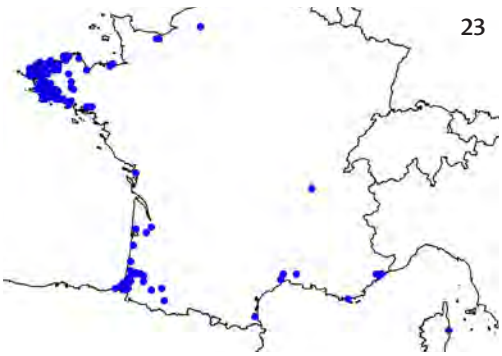
Other species of *Caenoplana*

Unnamed species of *Caenoplana* are known from the French West Indies, for example *Caenoplana* sp. "Brown" described, but without a binomial name, from the Australian fauna (Cannon and Winsor 2000, Winsor 1997), presently under investigation by us. Much work remains to be done on these *Caenoplana* from tropical regions.

Parakontikia ventrolineata

Parakontikia ventrolineata (Figs 22, 23) is highly abundant in parts of mainland France, particularly in Brittany, where the climate is mild and humid. The species comes from Australia and has also invaded much of the British Isles, especially the South, and other countries in Europe (Álvarez-Presas et al. 2014, Thunnissen et al. 2022). We suspect that the origin of the population found in France is Great Britain, which faces Brittany; amateur Breton gardeners have told us that it is common to make a return trip to Cornwall to bring back potted plants. In addition to mainland France, the species is also present on Reunion Island, in the Indian Ocean (unpublished data). There are also recent records from Mexico (De Luna and Boll 2023). Apart from a short article (Justine et al. 2014a), we have not published on the distribution of this species, but we have described its complete mitogenome. This mitogenome, the second obtained for a Rhynchodeminae, shares a certain number of characteristics with *Pl. manokwari*, namely a 32 bp overlap between ND4L and ND4, premature termination of ND5 by a tRNA-Ser, and an extra-long cox2 gene (Gastineau and Justine 2020).





Figures 22–23. *Parakontikia ventrolineata*: (23) Alive, specimen from France, MNHN JL56. Photo by Jean-Lou Justine, uploaded to Wikipedia, license CC-BY. Original file: https://commons.wikimedia.org/wiki/File:Geoplanidae_Kontikia_ventrolineata_MNHN_JL56_with_scale_-_red_background.JPG. (23) Map of occurrence in mainland France including Corsica. Based on 310 observations in the Openobs database.

Parakontikia ventrolineata displays a particular behavior that is not found in other species. Individuals tend to take refuge in the morning on strawberries and vegetables close to the ground, particularly the holes made in strawberries by slugs. It also has a marked tendency to invade fallen fruit, particularly apples. This behavior means that it is considered a nuisance by amateur gardeners, who see their crops invaded by small black and sticky worms (Justine et al. 2014a).

Other species

Dolichoplana striata

Dolichoplana striata is a very large species (20 cm) that can be confused with *B. kewense* in the absence of a photograph of the head, but the pattern of the lines on the dorsal side still allows us to separate it. There are no records in the open in mainland France for this species which clearly has affinities for the tropical climate. There are, however, a few records from Spain (Álvarez-Presas et al. 2014) and for greenhouses in Germany (Pfitzner 1956, 1958) and from Italy (Mori et al. 2022b). The species is present, but never very abundant, in various French overseas territories with a tropical climate, such as French Polynesia, Mayotte, and Reunion Island. We have not yet published our findings on this species.

Australopacifica atrata

Australopacifica atrata (Fig. 24) is theoretically not present in France, but it presents morphological similarities that could cause it to be confused with *Pa. ventrolineata* based on the often-imperfect photographs obtained from citizen science. The species has recently been found in the southern British Isles, where *Pa. ventrolineata* is also highly abundant (Jones 2019) and sequences of specimens from Great Britain have been recently published (Álvarez-Presas et al. 2023). Only a close examination of specimens or a genetic analysis can distinguish it from *Pa. ventrolineata*. We have described its complete mitogenome from specimens collected in Australia (Gastineau et al. 2022), which will make it possible to produce molecular tools that could be useful in the future in monitoring and conservation biology to distinguish the species from *Pa. ventrolineata*.

Figure 24. *Australopacifica atrata*, alive. Specimen from Australia, dorsal view. Photo by Reiner Richter. From Gastineau et al. (2022).

Amaga expatria

Amaga expatria (Figs 25, 26), originally described from a few specimens found in a botanical garden in Bermuda (Jones and Sterrer 2005), is relatively abundant in the islands of the French West Indies, Guadeloupe and Martinique (Justine et al. 2020a). It is a large species that is quite spectacular with its flat shape and its darker spotted yellow color. We have redescribed the external anatomy and histology of the species, and characterized its mitogenome, which is the second and only known Geoplaninae mitogenome after that of *O. nungara*. After this sequencing, the possibility mentioned by Solà et al. (2015), according to which some genes had non-canonical start codons, was re-evaluated. We know that the species consumes molluscs and earthworms, based on local observations in live animals and our molecular study of prey DNA (Justine et al. 2020a). There are no scientific papers on this species outside Bermuda, Guadeloupe, and Martinique, but there are many records in Trinidad and Tobago in iNaturalist (https://www.inaturalist.org/observations?taxon_id=1153578).

Figure 25. *Amaga expatria*, alive, dorsal view, specimen from Guadeloupe. Photo by Pierre and Claude Guezennec (anterior tip is left). From Justine et al. (2020a).

Marionfyfea adventor

Marionfyfea adventor (Fig. 27) was described in 2016 from specimens collected in the United Kingdom and the

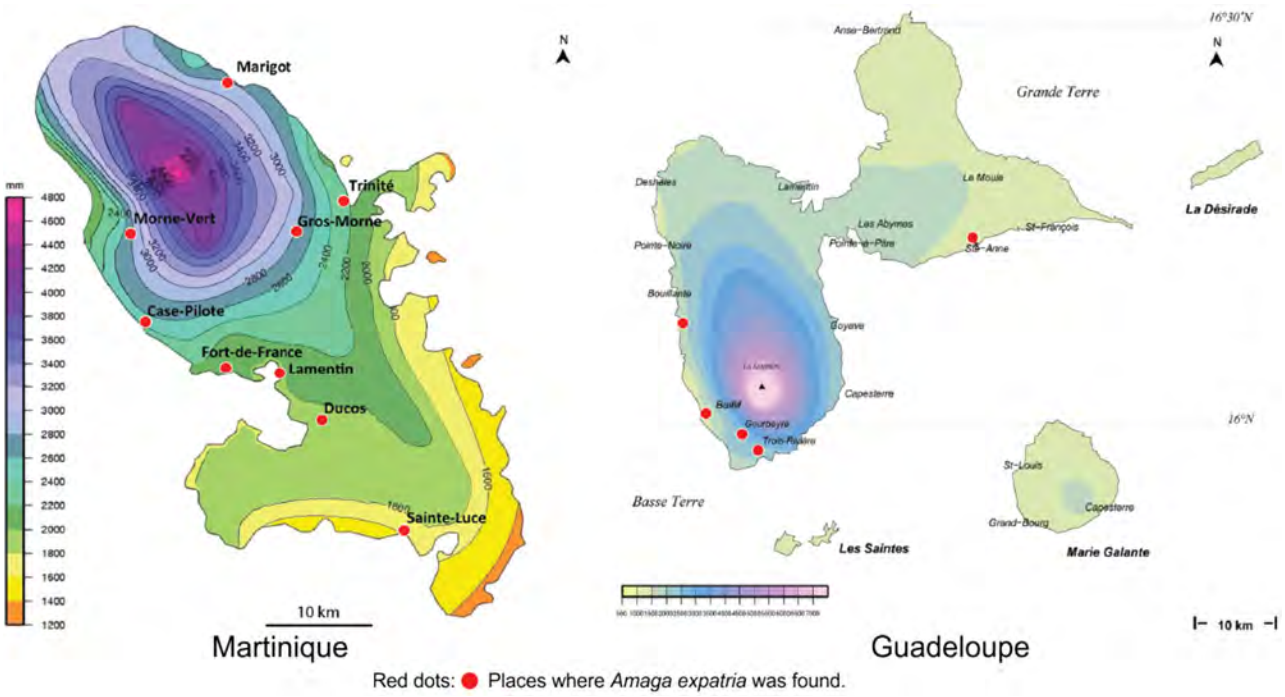


Figure 26. *Amaga expatria*, maps of records in Martinique and Guadeloupe. The background colors indicate annual rainfall. Maps by Jessica Thévenot, background provided by Météo-France and used with authorization. From Justine et al. (2020a).

Figure 27. *Marionfyfea adventor*, alive, from Saveuse, Somme, France. Photo by Simon Barbier, license CC-BY. Original file: https://commons.wikimedia.org/wiki/File:Marionfyfea_adventor_(Geoplanidae)_-_Saveuse,_France.jpg.

Netherlands, and a mention in France that we communicated to the authors (Jones and Sluys 2016). Since then, we have seen only a few mentions of the species in France; the species is very small compared to the others discussed here, and it is not surprising that it escapes observers. The species was recently reported from Belgium (Soors et al. 2022) and Spain (Rojo et al. 2024), and some molecular information was recently reported for a British specimen and for a French specimen from Brittany (Álvarez-Presas et al. 2023).

Endeavouria septemlineata

Endeavouria septemlineata (Fig. 28) is considered invasive in several regions of the world (De Luna and Boll 2023) and has been found once in French Polynesia (Justine et al. 2018a). There is also a record from New Caledonia in iNaturalist (https://www.inaturalist.org/observations/56008643). A recent record in Italy (Mori et al. 2022a) could indicate that the species has also invaded the southern regions of Europe.

Various Microplaninae

Microplaninae are native to Europe. We have not yet published findings on the Microplaninae from mainland France, mostly because the species are generally small and escape the attention of citizen scientists. We know, however, that mainland France harbors a variety of species (Alvarez-Presas et al. 2022) and it is likely that many native European species remain to be described (Mateos et al. 2017). Species recorded are: *Microplana henrici* (Bendl, 1908), *Microplana howesi* (Scharff, 1900), *Microplana mahnerti* Minelli,

Figure 28. *Endeavouria septemlineata*, alive, from Mt Marau, Tahiti, French Polynesia. Photo by Justin Gerlach. From Justine et al. (2018a).

1977, *Microplana pyrenaica* (von Graff, 1893), *Microplana scharffi* (von Graff, 1896), and *Microplana terrestris* (Müller, 1774). Sequences reported from French specimens (Mateos et al. 2017) indicate that *Microplana hyalina* Vila-Farré & Sluys, 2011 and *Microplana* cf. *aixandrei* are also present in France. An unformally published document (Noël and Gros 2015) states that *Microplana kwiskea* Jones, Webster, Littlewood & McDonald, 2008 is present in the South of France and we confirm since this was based on our own unpublished sequence.

Species from the French Caribbean

The French Caribbean includes several islands, the largest being Guadeloupe and Martinique, as well as Saint-Martin and Saint-Barthélemy. A particularity is the abundant presence of the large species *Am. expatria*, which is probably a species from South America (Justine et al. 2020a). We have reported the very recent invasion of these islands by *Pl. manokwari* (Justine et al. 2021), an invasive species which has also recently been spotted on other islands of the region (Brown et al. 2022, Kostik 2019). The fauna of Guadeloupe and Martinique includes a significant number of other species (Table 2), including invasive ones such as bipaliines (Justine et al. 2018b) and several species of *Anisorhynchodemus* and *Dolichoplana*, but some could be endemic. We are currently working on this topic.

Species from New Caledonia

New Caledonia is a large island in the Southeast Pacific Ocean and has a unique feature of its land flatworm fauna, in that it has numerous endemic species (Winsor 1991a) (Table 3). We have received some reports of this endemic fauna, and these are often very spectacular. Of note, New Caledonia was relatively recently invaded by *Pl. manokwari* (Justine et al. 2015).

Table 2. Checklist for the French Caribbean and islands in the Indian and Pacific oceans.

Flatworm species	French Caribbean				Islands in the Indian and Pacific oceans			
	Saint Barthélemy	Guadeloupe	Martinique	Saint Martin	Mayotte	Reunion	Wallis & Futuna	Tahiti and the Society Islands
Amaga expatria		+	+					
Anisorhynchodemus spp.		+	+			+		+
Bipalium kewense						+		
Bipalium vagum		+	+			+		
Caenoplana coerulea						+		
Caenoplana sp. "brown"	+	+						
Diversibipalium mayottensis					+			
Diversibipalium multilineatum			+					
Dolichoplana spp.		+	+		+	+		+
Endeavouria septemlineata								+
Obama nungara						+		
Parakontikia ventrolineata			?			+		
Platydemus manokwari		+	+	+			+	+
Unidentified Geoplanidae		+	+	+		+		

Species from French Guiana

French Guiana, by its location and its virgin tropical forest, is of course populated by numerous native species belonging to the Geoplaninae, like the neighboring countries of South America. The two invasive hammerhead flatworms *B. kewense* and *B. vagum* are also present (Justine et al. 2018b), along with *Dolichoplana striata* and *Caenoplana* sp. "brown". We have received numerous reports from French Guiana, often for spectacular flatworms. To date, we have identified 18 "species" as recognizable taxonomic units, but have not been able to identify them further based solely on photographs. They might correspond to undescribed species.

The mitogenomes of the Geoplanidae

When we started this work, only one complete geoplanid mitogenome was available, that of *O. nungara* (Solà et al. 2015). To date, we have published the complete mi-

Table 3. Land planarians from New Caledonia and the Loyalty Islands. Based on the literature (Busson 1903, Schröder 1924, Winsor 1991a) and specimen records.

Land planarian species	Observations	
Anisorhynchodemus forrestrianus (Schröder, 1924)		
Anisorhynchodemus lindsayianus (Schröder, 1924)		
Anisorhynchodemus mitchellianus (Schröder, 1924)		
Anisorhynchodemus warburtonianus (Schröder, 1924)	*	
Australopacifica austiniana (Schröder, 1924)		
Australopacifica chamissoniana (Schröder, 1924)		
Australopacifica dietrichiana (Schröder, 1924)		
Australopacifica eschscholziana (Schröder, 1924)		
Australopacifica gregoryana (Schröder, 1924)		
Australopacifica huttoni (Schröder, 1924)		
Australopacifica kotzebueana (Schröder, 1924)	*	
Australopacifica leichardtiana (Schröder, 1924)		
Australopacifica muelleriana (Schröder, 1924)		
Australopacifica rouxiana (Schröder, 1924)	*	
Australopacifica sarasiniana (Schröder, 1924)		
Australopacifica semoniana (Schröder, 1924)	*	
Australopacifica sowerbyi (Graff, 1899)		
Australopacifica willeyi (Busson, 1903)	*	
Australopacifica zebra (Schröder, 1924)		
Dolichoplana striata Moseley, 1877	+	Introduced
Endeavouria septemlineata (Hyman, 1939)		Introduced
Kontikia cookiana (Schröder, 1924)	NC*	
Kontikia forsterorum (Schröder, 1924)	*	
Pimea monticola Winsor, 1990		
Platydemus manokwari de Beauchamp, 1963		Introduced

+Locality: Yahoué at https://www.inaturalist.org/observations/53820987, and https://www.inaturalist.org/observations/155300952; Records from the Loyalty Islands are indicated by *, and NC* when the species is also present in New Caledonia.

togenomes of 12 species: the bipaliins *B. kewense* (Fig. 29), *B. admarginatum*, *B. adventitium*, *B. vagum*, *D. mayottensis*, *D. multilineatum* and *V. covidum*, the geoplanins *O. nungara* and *Am. expatria*, and the rhynchodemins *Pa. ventrolineata*, *Au. atrata* and *Pl. manokwari* (Table 4). We also have unpublished data for several other species.

In most cases, we were able to circularize the mitogenomes, but the presence of repeated parts means that the true length is likely greater than what we found. These excessive lengths and repeats cannot be resolved by short-read sequencing techniques, such as those we have used so far, and would instead require the use of long-read sequencing.

Length of mitogenomes

The longest mitogenome among the Geoplanidae is that of *Pl. manokwari*, and the longest mitogenome among the Bipaliinae is that of *B. admarginatum* (Table 4). This additional length results from intergenic sequences, notably a large region located between rrnL and cob. A comparison of the size of this region among Geoplanidae is shown in Table 4. More generally, it should be noted that the Geoplanidae mitogenome is not compact, with intergenic zones scattered throughout.

Position of ARNt-Cys

Based on the data currently available, the Rhynchodeminae differ from the Bipaliinae and the Geoplaninae by the position of their tRNA-Cys. For the Rhynchodeminae *A. atrata*, *Pl. manokwari* and *Pa. ventrolineata*, tRNA-Cys is located between the cox3 and atp6 protein-coding genes, grouped with tRNA-Ile, tRNA-Gln and tRNA-Lys, as the first tRNA of this group. For the Bipaliinae *B. kewense* and the Geoplaninae *O. nungara* and *A. expatria*, tRNA-Cys is located between the gene encoding the ND2 protein and the 12S rRNA gene, grouped with tRNA-Met and tRNA-His, located after these two tRNAs (Table 4).

The missing tRNA-Thr

No Thr-tRNAs could be detected in the mitogenome of all Rhynchodeminae species studied, namely *Pa. ventrolineata*, *Pl. manokwari* and *Au. atrata*, and also in the Bipaliinae *B. admarginatum* and *V. covidum* (but it is present in the other Bipaliinae) (Table 4). Among other species, tRNA-Thr was found between the 16S rRNA gene and the protein-coding cob gene, clustered with tRNA-Leu and tRNA-Asn. There is a difference between the Geoplaninae, in which the order of this group is "16S, tRNA-Thr, tRNA-Leu, tRNA-Asn, cob" and the Bipaliinae *B. kewense*, in which the order is "16S, tRNA-Leu, tRNA-Thr, tRNA-Asn, cob". For the moment, we prefer to refrain from overinterpreting this characteristic while awaiting data on other species. It is possible that this tRNA exists within all mitogenomes, but in this case, with a non-conserved structure of its D and T loops, the only conserved feature being the anticodon.

Long cox2

The cox2 gene presents a significant additional length in all Rhynchodeminae studied (*Pa. ventrolineata*, *Pl. manokwari* and *Au. atrata*) (Table 5). This extra length does not correspond to a missing stop codon, because it is located in the middle of the gene, and not at the 3'end. The size of the putative cox2 protein of Rhynchodeminae is of the order of 434 to 452 amino acids, compared to those of Bipaliinae, varying between 225 to 260 amino acids. This excess length of cox2 is not limited to Geoplanidae, as it should be noted

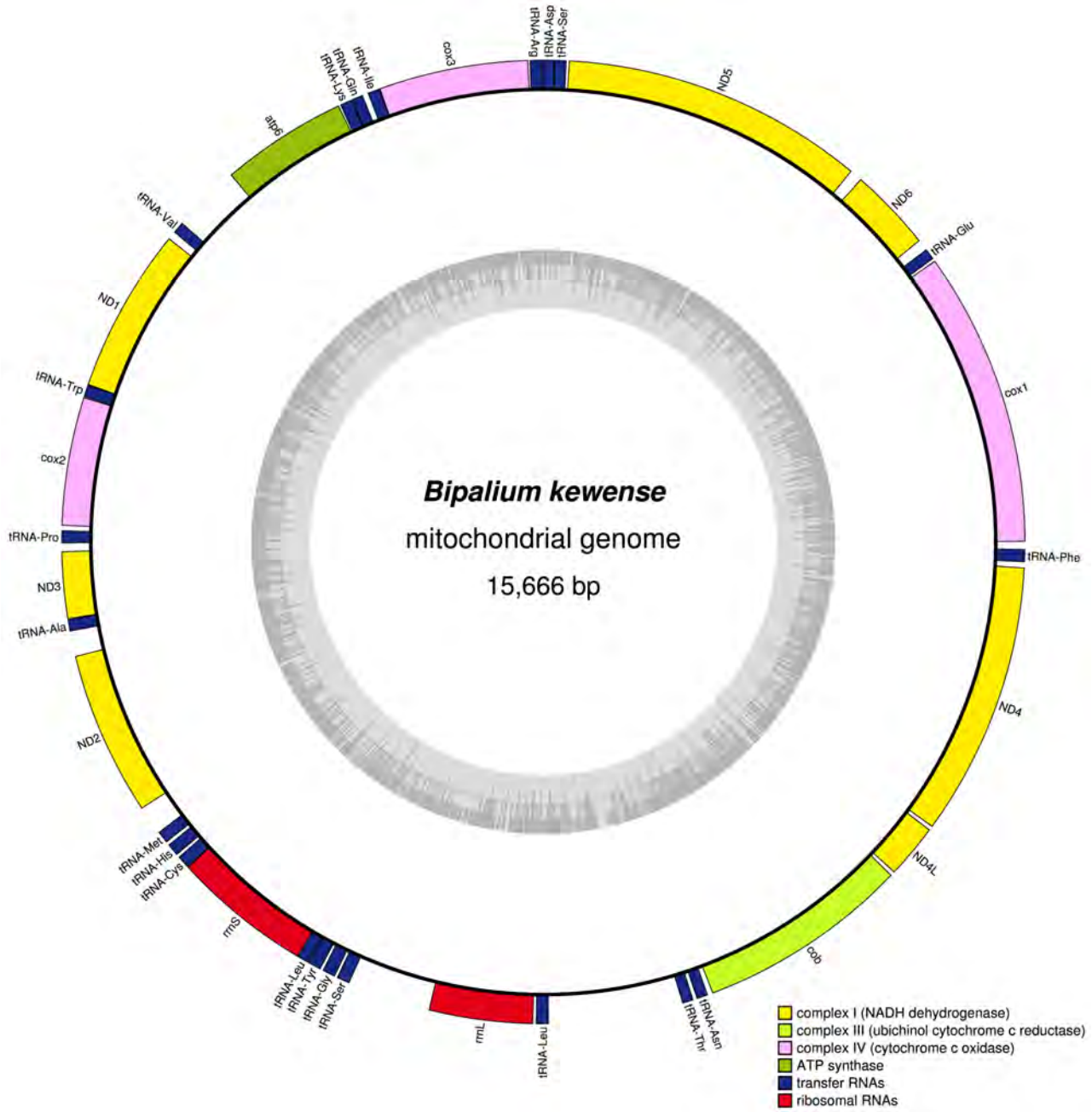


Figure 29. *Bipalium kewense*, genomic map of specimen MNHN JL184A. The mitogenome is 15,666 bp long and contains 12 protein coding genes, two ribosomal RNA genes, and 22 transfer RNA genes. From Justine et al. (2022a).

that Dugesiidae *Girardia* spp. also display very long cox2 genes (Sequences registered in GenBank as KP090061 and MW972220). However, this overlength in *Girardia* spp. is not located in the middle of the open reading frame, as in Rhynchodeminae, but at the C terminus, and could therefore be more the result of a missing stop codon, which should be re-examined. The extra length observed in Rhynchodeminae also does not correspond to an intron, nor does it appear to be an intein. Its distribution and conservation among the Rhynchodeminae remain to be studied.

Table 4. Geoplanidae mitogenomes and various characteristics.

Species	GenBank	Size (bp)	Length of the rrnL-cob intergenic region and presence of tRNA	Reference
Bipalium admarginatum	OQ308795	18 990	2288 bp (tRNA-Leu, tRNA-Asn)	Soo et al. (2023)
Bipalium kewense	MK455837	15 666	934 bp (tRNA-Leu, tRNA-Thr, tRNA-Asn)	Gastineau et al. (2019)
Bipalium vagum	MZ561468	17 149	1552 bp (tRNA-Leu, tRNA-Thr, tRNA-Asn)	Justine et al. (2022a)
Bipalium adventitium	MZ561467	15 494	741 bp (no tRNA detected)	Justine et al. (2022a)
Diversibipalium multilineatum	MZ561469	15 660	Impossible to circularize (tRNA-Leu, tRNA-Thr, tRNA-Asn)	Justine et al. (2022a)
Diversibipalium mayottensis	MZ561470	15 989	1479 bp (tRNA-Leu, tRNA-Thr, tRNA-Asn)	Justine et al. (2022a)
Vermiviatum covidum JL351	MZ561472	15 540	691 bp (tRNA-Leu, tRNA-Asn)	Justine et al. (2022a)
Vermiviatum covidum JL090	MZ561471	15 524	672 (tRNA-Leu, tRNA-Asn)	Justine et al. (2022a)
Platydemus manokwari	MT081580	19 959	2303 bp (tRNA-Leu, tRNA-Asn)	Gastineau et al. (2020)
Parakontikia ventrolineata	MT081960	17 210	766 (tRNA-Leu, tRNA-Asn)	Gastineau & Justine (2020)
Australopacifica atrata	OM456243	16 513	1033 (tRNA-Leu, tRNA-Asn)	Gastineau et al. (2022)
Amaga expatria	MT527191	14 962	640 (tRNA-Thr, tRNA-Leu, tRNA-Asn)	Justine et al. (2020a)
Obama nungara	KP208777	14 909	Not fully resolved (tRNA-Thr, tRNA-Leu, tRNA-Asn)	Justine et al. (2022b), Solà et al. (2015)

Table 5. Amino acid (AA) sizes of the *cox2* protein encoded by available mitogenomes of the Continenticola (Tricladida).

Name	Family	GenBank	Size of the putative cox2 protein (in AA)	Specific features
Schmidtea mediterranea	Dugesiidae	JX398125	292	Start codon not determined
Girardia sp.	Dugesiidae	KP090061	389	Start codon not determined
Girardia tigrina	Dugesiidae	MW972220	389	Start codon not determined
Dugesia japonica	Dugesiidae	AB618487	227	NA
Dugesia ryukyuensis	Dugesiidae	AB618488	230	TAA stop codon completed by the addition of 3' A residues to the mRNA
Crenobia alpina	Planariidae	KP208776	239	NA
Phagocata gracilis	Planariidae	KP090060	297	NA
Obama nungara	Geoplanidae	KP208777	259	Start codon not determined
Amaga expatria	Geoplanidae	MT527191	260	Start codon not determined
Bipalium kewense	Geoplanidae	MK455837	225	NA
Bipalium vagum	Geoplanidae	MZ561468	229	NA
Bipalium adventitium	Geoplanidae	MZ561467	227	NA
Diversibipalium multilineatum	Geoplanidae	MZ561469	228	NA
Diversibipalium mayottensis	Geoplanidae	MZ561470	246	NA
Vermiviatum covidum	Geoplanidae	MZ561471, MZ561472	248	NA
Platydemus manokwari	Geoplanidae	MT081580	452	NA
Parakontikia ventrolineata	Geoplanidae	MT081960	433	NA
Australopacifica atrata	Geoplanidae	OM456243	434	NA

A different genetic code?

For several of the sequenced species, but especially for the Geoplaninae, it has sometimes been impossible to find a canonical start codon for some of the genes encoding conserved mitochondrial proteins. A growing number of reports suggest that TTG and TTA could equally act as initiation codons. This particularity deserves more in-depth studies, the first step of which could be obtaining more mitogenomes for comparison purposes.

Phylogenies based on mitogenome proteins

The maximum likelihood phylogenetic tree (Fig. 30) based on concatenated mitogenome proteins clearly distinguishes the Geoplanidae from other Continenticola families for which mitogenomes are available, namely the Planariidae and Dugesiidae. Within the family Geoplanidae, two major clades emerge: Geoplaninae, and a clade containing Bipaliinae and Rhynchodeminae. Each subfamily is well individualized, but there is currently no information on two

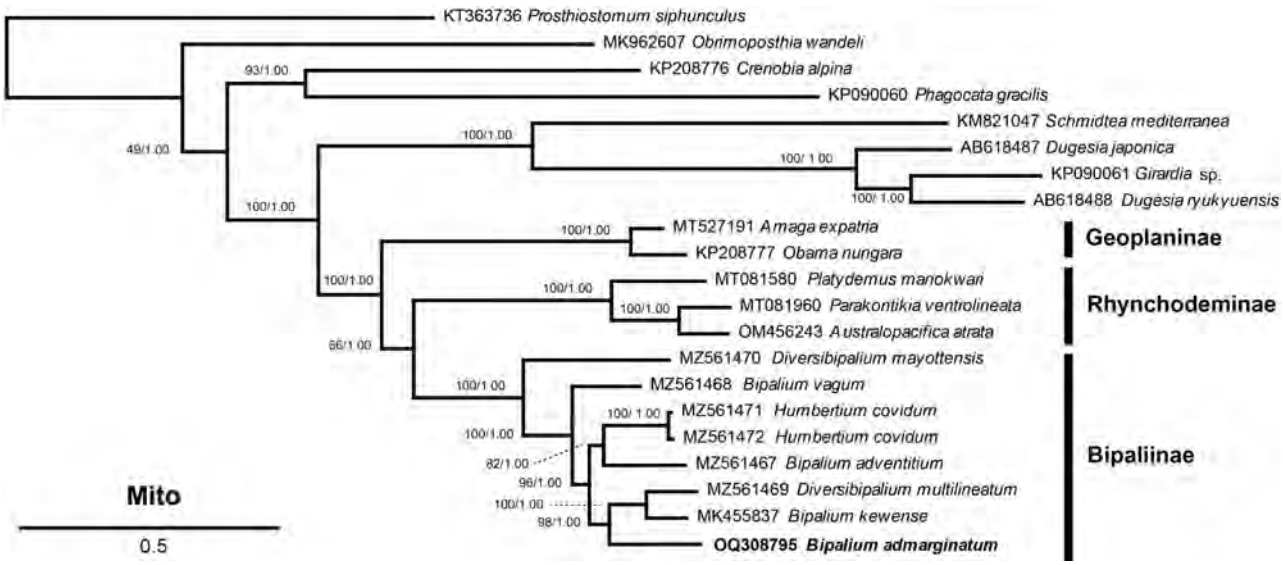


Figure 30. Maximum likelihood (ML) phylogenetic tree obtained from concatenated amino acid sequences of the mitochondrial proteins of various flatworms, including all geoplanids with published mitogenomes (2023). The tree represents both ML and Bayesian inference (BI) phylogenies, performed using mtZOA+I+G4 and CPREV+I+G4 models of evolution, respectively. The tree with the best likelihood is shown, and bootstrap values are indicated. The BI tree had an identical topology; posterior probabilities are indicated on the right as decimal values. Subfamilies of Geoplanidae are indicated on the right. From Soo et al. (2023).

subfamilies, the Microplaninae and the recently characterized Timyminae (Almeida et al. 2021).

Communication to the public as a key to the success of citizen science

Our first paper on the presence of *Pl. manokwari* in France (Justine et al. 2014b) had unexpected success in the media and allowed us to understand that communication with the public was important to obtain new data (Fig. 31). We quickly discovered that the public sent many new records just after an article was published in a newspaper, or when radio and televisions stations aired interviews.

A type of virtuous circle, as a positive loop including citizen science and publishing from these data, was established and can be detailed as follows:
Scientific paper ➜ Press release ➜ Interviews on various media (radio, television, newspapers, and magazines) ➜ More people informed about species ➜ More records and specimens obtained from citizen science ➜ More data ➜ Another scientific paper.

In other words, while it is best practice for scientists to communicate about their research when they have the opportunity, communication with the public is something more here: it is the means of obtaining more data.

In this adventure, we were helped by excellent articles published by journalists in newspapers from France such as Le Monde (Morin 2018) and Libération (Bardou 2018) and from other countries such as The Independent (UK) (Gabbatiss 2018), and the Washington Post (United States) (Guarino 2018). We also regularly wrote our own popular pieces in the media website "The Conversation" which provides papers under a Creative Commons licence which then can be freely republished by all media; these were published in French (Justine 2017, 2018a, Justine and Jones 2020b, Justine and Winsor 2020b, 2022a, 2022c, Fourcade et al. 2022a, Roy and Justine 2022, Justine et al. 2023c), English (Justine 2018b, Justine and Jones 2020a, Justine and Winsor 2020a, 2022b, Justine et al. 2023a) and even, in one case, Indonesian (Justine et al. 2023b). One of these popular pieces about hammerhead flatworms (Justine 2018a) reached more than 2,000,000 reads (Justine 2019).

For an optimal impact on the public, photographs should be selected according to their attractiveness. Images such as *Pl. manokwari* eating a snail (Fig. 2) or *O. nungara* an earthworm (Fig. 4) were reproduced on thousands of websites in 2014 and 2010, respectively when our papers were published (Justine et al. 2014b, 2020c). Images of bipaliines with their head raised up (probably instinctively interpreted as "menacing") such as *D. multilineatum* (Fig. 12)

Figure 31. A sample of photographs of *Obama nungara* in gardens, received from non-professionals. The photographs in (A), (E) and (H) are examples of the light brown color; others are of the dark form. Scales in (B) and (G): centimeters and millimeters; diameter of Euro 10 cent coin in (H) and (I): 19.5 mm; other images are unscaled. All authors have agreed to publication of their photographs under a CC-BY 4.0 license: (A) Cathy Constant-Elissagaray, (B) Nicolas Armengaud, (C) Julien Silvert, (D) Frédéric Madre, (E) Benjamin Klein, (F) Françoise Bronnec, (G) Louise Lejus, (H) Fanny Tourraille (I) Christophe and Amauray Amiand. From Justine et al. (2020c).

or *V. covidum* (Fig. 16) were also highly used by the media in 2018 and 2022 when the papers were published (Justine et al. 2022a, 2018b). We are very grateful, in this regard, to Pierre Gros who demonstrated impressive patience and talent when taking these photographs.

The impact on the public of our scientific papers can be evaluated from their Altmetric scores. The 2018 paper about hammerhead flatworms (Justine et al. 2018b) with its catchy title "Giant worms *chez moi*…" has currently (January 2024) been read more than 50,000 times and has an Altmetric score of 924, reflecting the fact that it has been cited in 116 news stories (https://www.altmetric.com/details/42297526). We emphasize that this is not a question of boasting about a significant number of readings. We are well aware that very few members of the public have read in detail, or understood, this article, despite the staggering 50,000 reads. On the other hand, we want to share our experience and show the ingredients that can make a citizen science approach work; we hope that other teams will try this approach in other countries.

Final remarks

Mainland France, but also the French overseas territories, have been invaded by around twenty species of terrestrial Platyhelminthes, whose origins are varied (South America, Australia, New Zealand, and Asia). Citizen science has made it possible to map invasions and also to obtain specimens in a very efficient way. While in 2013 there was practically no bibliography on the subject for France and no researchers working on the subject, in ten years we have built a fairly large body of publications, which includes both morphological and molecular studies. The subject is far from exhausted, and practically nothing has been published on several species from mainland France such as *Caenoplana* spp. and *Pa. ventrolineata*, which are nevertheless abundant. The Microplaninae of mainland France were also almost untouched. The overseas territories are a barely explored source of biodiversity of invasive and native species of Geoplanidae and much remains to be done.

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