Proc. Isle of Wight Nat. Hist. Archaeol. Soc. ***39***, *71-76 (pub 2025)*

A UNIQUE STRATIFIED OCCURRENCE OF *Plagiolophus minor* FROM THE LATE EOCENE, GURNARD MEMBER OF HOWGATE BAY, ISLE OF WIGHT

Martyn C G Hornett

Abstract: *In 2022, a partial mandible of Plagiolophus minor was discovered in-situ from the Gurnard Member (Solent Group) of Howgate Bay, Isle of Wight. This represents the first recorded in-situ large mammal fossil from this part of the Late Eocene succession, which has otherwise yielded sparse and poorly documented ex-situ mammal remains. Stratigraphic logging and sedimentological analysis indicate that the mandible was preserved within an anoxic substrate under brackish water conditions.*

Keywords: Mammal, *Plagiolophus*, Palaeothere, Eocene, Isle of Wight.

Introduction

A partial mandible of *Plagiolophus minor* (Cuvier, 1804) consisting of the right and left dentaries was found within the lower part of the fossil-rich, Late Eocene Gurnard Member (Solent Group) in Howgate Bay (SZ 647 868) on the Isle of Wight. *Plagiolophus minor* which was the size of a modern roe deer (*Capreolus capreolus*), is found at several sites in Europe, and was the only member of the Palaeotheriidae to survive the "Grande Coupure" faunal turnover into the Oligocene (Jehenne and Brunet, 1992). The diet of *Plagiolophus minor* was discussed by Remy (2004) based on the gross morphology of the teeth and qualitative mesowear suggesting that *P. minor* fed on both soft foliage and more abrasive grasses.

Further study by Joomun *et al*. (2008) determined that the species was a leaf browser, with a small proportion of the diet consisting of soft fruit and consumed fewer abrasive foods than other palaeotheres. Perales-Gogenola *et al*. (2022) showed that despite the wide chrono-spatial distribution of *Plagiolophus* sp. their diet did not fundamentally change between the middle Eocene and the early Oligocene. Their research concluded that *Plagiolophus* was a highly selective feeder that concentrated on a few plants with tough leaves that required a slicing motion, and they would have avoided lignified or hard material that required a crushing action.

Howgate Bay is located on the north-east coast of the Isle of Wight. The Gurnard Member is a heterolithic succession comprising a series of well-bedded clays, marls and subordinate limestones of both quasi-marine and terrestrial origin. They yield a diverse mollusc, fish, reptile, and vertebrate fauna, which has been recorded by many researchers, including Webster (1814); Forbes (1853); White (1921); Daley and Edwards (1971, 1990); and Gale (2021). However, relatively few larger mammalian specimens have been reported from within the Gurnard Member. Of these, the majority originate from the coast between Thorness Bay and Yarmouth, 32 km west of Howgate Bay. Hooker (2010) recorded small mammal teeth from the Bembridge Oyster Bed and the underlying clays in Howgate Bay. The only other accurately horizoned mammalian fauna (recorded at Dinosaur Isle Museum) come from a sandy limestone bed (bed G9B) and overlying muds, (bed G10) of Hooker (2021) which were studied by Ford, Ensom and Bosma in the 1960s and 1970s. That mammal fauna comprised microfossils found by sieving. Therefore, very few large mammalian taxa are known from the Gurnard Member with most specimens in museums from the early 20th century simply recorded as being from the "Isle of Wight". According to Hooker (2010), the majority of finds of large mammals all appear to have come from the top of the Gurnard Member close to the Black Band (the base of the overlying Hamstead Member) and of those finds, only one was apparently found *in-situ*. Records of finds in the Dinosaur Isle Museum collection in Sandown are like that of the Natural History Museum in London. Therefore, this paper reports, for the first time the finding of an in-situ large mammal fossil from the lower part of the Gurnard Member.

Geological Setting of the Gurnard Member

The Eocene sediments of Whitecliff and Howgate Bays have been investigated by several researchers including Daley (1972, 1973a, 1973b, 1999); Daley & Edwards (1974, 1990); Keen (1977); Collinson (1983); Hooker *et al*. (1995), who identified a range of depositional environments, including marginal marine, brackish lagoon, coastal lake and floodplain lake settings. The relative position of the land and sea was changing in response to movements in sea level, and continuing uplift of the Isle of Wight monocline, (Parrish *et al*., 2018). The consequence of these changes were depositional fluctuations which resulted in the sediments being deposited in the Howgate Bay area as sometimes marginal marine and at other times non-marine (Hooker *et al*., 1995).

Within Howgate Bay, the lowest Gurnard Member sediments are now considered a transgressive surface, formed under sub-tropical conditions, which thins northwards and onlaps older sediments. The bulk of the Gurnard Member was deposited in this regressive phase when continental conditions were gradually re-established (Gale, 2019). It is probable that the Solent area was a distal part of a river, as sedimentation in the Gurnard Member reflects deposition in a sluggish-water estuary or lake. The lack of fluvial sediment implies that the local landscape remained low, with stable, densely vegetated surfaces during late Priabonian times (Hooker *et al*., 1995). The marginal marine environment is represented by the Bembridge

Oyster Bed (Forbes, 1856, King, 2016) which contains abundant *Ostrea*, generally as drifted, separated valves and shell debris. Studies of ostracods (Keen, 1966), Foraminifera (Bhatia, 1955) and barnacles (Gale, 2020) support the existence of brackish or saline conditions. This marginal marine environment was superseded by a lagoonal environment. These sediments are predominantly blue-grey clays, homogeneous or with varve-like lamination containing a brackish fauna, dominated by the bivalve *Polymesoda*. It is from the higher-level beds of this estuarine environment that the *Plagiolophus* mandible was recovered. Within these facies, there is a shell bed at the base of Bed G4, which in places is heavily cemented with pyrite and persists across the study area. The bed was a good marker horizon for this study and is therefore numbered Bed G4a (Table 1).

This bed has yielded several well-preserved turtles (family Trionychidae), which are now in the Dinosaur Isle Museum collection. The top of the recorded section is characterized by knots of serpulid worm tubes, which probably represent a short-lived saline inundation during a period when fully freshwater conditions were established over the area. The Gurnard Member above the serpulid bed is outside the scope of this study, but is interpreted as representing deposition in extensive, low-lying, floodplain lakes which were periodically incorporated into a river system. The environment is characterized by freshwater gastropods, and occasionally the bivalve *Unio* and the sediments are olive-brown clays, with some horizontal lamination (Daley, 1972).

Methods

Fieldwork in Howgate Bay was possible thanks to permission from the Isle of Wight Council. Specimens were deposited at Dinosaur Isle Museum (Sandown, IOW, UK) under the collection number IWCMS: 2025.8.

Examination of the dentaries was carried out under a binocular microscope to determine if there was any bone modification by weathering, abrasion, trampling, carnivore or rodent activity.

The Gurnard Member is well exposed in Howgate Bay, and the lower six meters of the Member were logged for this paper using direct bed measurements. The numbering sequence for the beds is based on Hooker (2021) and Daley (1973). Identified within the presented stratigraphical framework is the horizon that produced the partial mandible discussed and figured here (Table Institutional abbreviation: IWCMS = Isle of Wight Council Museum Service.

Systematic Palaeontology

Order PERISSODACTYLA Owen, 1848b

Suborder HIPPOMORPHA Wood, 1937

Family PALAEOTHERIIDAE Bonaparte, 1850

Genus *Plagiolophus* Pomel, 1847

Plagiolophus minor (Cuvier, 1804)

Description of the material

A partial mandible (Fig. 1) missing the anterior portion of both dentaries containing the incisor / canine teeth. The left dentary is missing the coronoid process and condyle. The right dentary retains most of the coronoid process, but is missing the condyle. Both the left and right dentaries have a mandibular tooth row consisting of the P_2-P_4 and M_1-M_3 teeth *in*

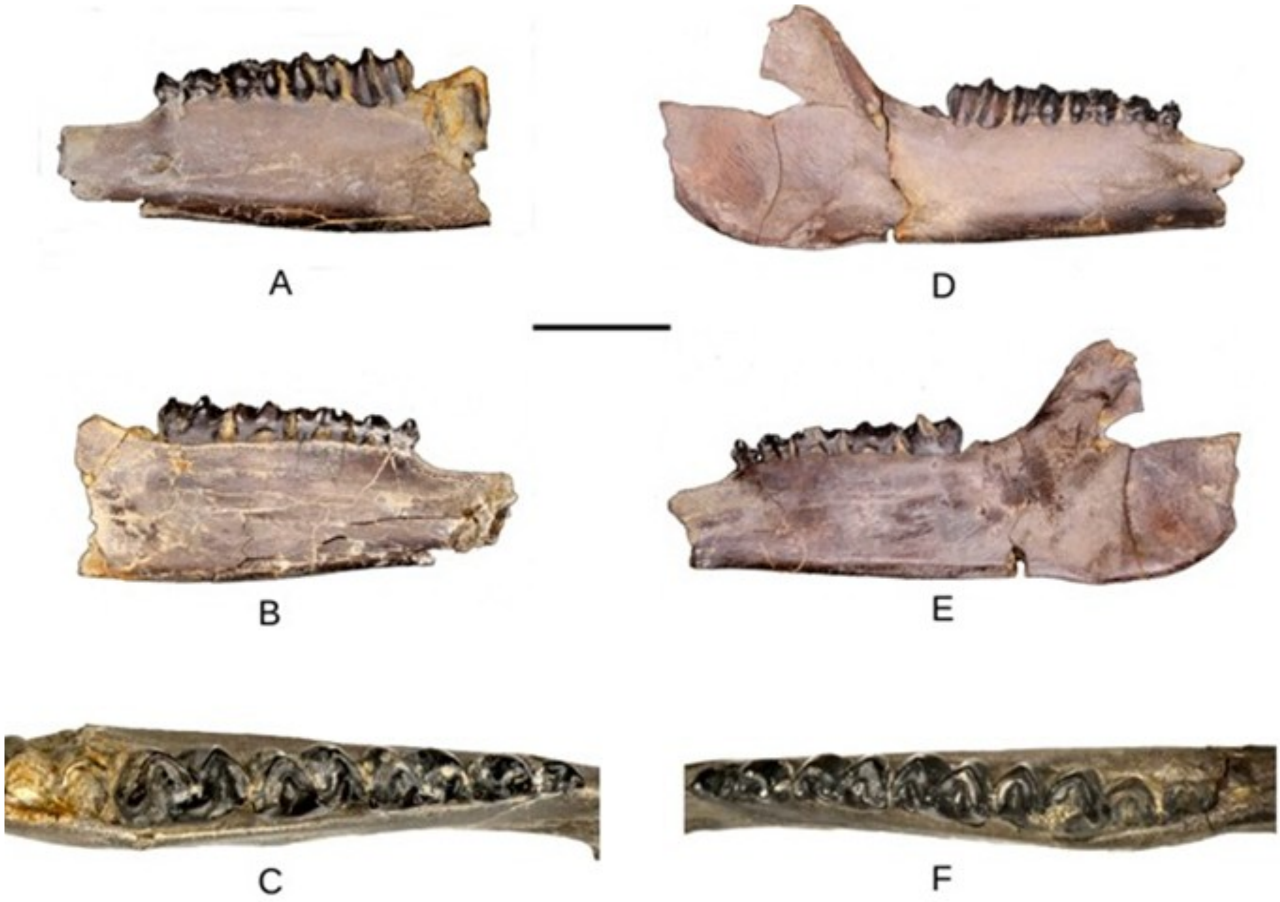

Fig. 1: *Plagiolophus minor:* Left dentary in A: Buccal View. B: Lingual View. C: Occlusal View. Right Dentary in D: Buccal View. E: Lingual View. F: Occlusal View. Scale bar for A, B, D and E = 30mm. Scale bar for C and F = 20mm

Table 1: A refined sedimentary Log of the Lower Gurnard Member in Howgate Bay (647 868), based on original field observations and the work of Hooker (2010) and Daley (1973).

SCALE (m)	LITHOLOGY	Bed Number	Lithic Description	NOTES
		G6C	Pale green / buff mud	Partial articulated trionychid turtle has been recovered from this bed
		G6B	Blue grey mud	
		G6A	Grey green mottled mud	
5		G5	Pale green grey mud	Bands of gastropod shells, with occasional remains of trionychid and Emydidae turtles.
		G4B	Grey laminated mud	Many bands of *Polymesoda convexa* with original colour banding, occasional remains of trionychid and Emydidae turtle
4	*	G4B	Grey laminated mud	*Polymesoda convexa* with original colour banding but not in regular shell bands. (Plagiolophus partial mandible recovered at the level indicated by the ***)**
		G4A	Heavily pyritic shell band	Trionychid turtles in shell band of *Polymesoda*
3		G3C	Grey blue laminated mud	
2		G3B	Limestone	"Insect Limestone"
		G3A	Pale blue laminate mud	*Cordiopsis*, *Serpula tenuis* (forming mounds)
		G2	Cemented grey sand	"Bembridge Oyster Bed" *Ostrea vectensis, Balanus, Nucvla, Sinoda.*
1		G1C	Pale blue mud with silty lenses	*Potamides, Lymnaea*
		G1B	Grey nodular marl	
		G1A	Shelly muddy sand	*Planorbarius discus, Potamomya*

situ (Fig 1). In occlusal view the M_1 and M_2 comprise two main crescent shaped lobes which are rounded and concave on the lingual side, with the occlusal surfaces inclined slightly anteriorly. In both dentaries, the M_3 has not fully erupted and remains wholly within the alveolus. In the right dentary the M_3 is complete and in occlusal view the hypoconulid forms a third crescent shaped lobe. In the left dentary the posterior part of the M_3 is missing; consequently, in occlusal view only two crescent-shaped lobes are seen.

The structure of the P_2 is small and unicuspid. In occlusal view P_3 has a single crescent shaped lobe and the P_4 is molariform with two crescent shaped lobes, again with the occlusal surface inclined slightly anteriorly. The length of the mandibular tooth row is 63mm, and whilst neither dentary have the canine teeth preserved the left dentary has the remains of the canine tooth alveolus. The estimate of the post-canine diastema length is 21mm, this measurement shows a moderately elongated diastema. The Premolar-Molar Index (PMI: P_2-P_4/M_1-M_3x100 length ratio) in this specimen is 57.8% (P_2-P_4=23.5, M_1-M_3=40.6)

Discussion

The measurements of the mandibular tooth row (63mm) are consistent with *Plagiolophus minor* (60 to 70mm) *as* reported by Remy (2004). Furthermore, the 21mm estimate for the post-canine diastema shows it to be moderately elongated and is consistent with being 30% of the mandibular tooth row length, as also reported by Remy (2004) for *Plagiolophus minor*. The PMI for the specimen is 57.8% which is low when compared to *Paleotherium* (62-82%) but is within the range for *Plagiolophus minor* (44-59%). Remy (2004) described a progressive lowering of this ratio over time but also recognised a high variability in this index between individuals.

Remy (2004) reported that juvenile dental fossils are rare; consequently, it is difficult to reconstruct the precise dentition stages. However, from his investigations the sequence of appearance of permanent teeth in *Plagiolophus* is probably M_1-M_2-P_2-(P_3 and P_4)-M_3 in both the mandible and the maxilla. Therefore, as the M_3 tooth has not fully erupted in this specimen this indicates that it is from a sub-adult and that all teeth are permanent.

Taphonomy

The bed from which the *Plagiolophus minor* mandible was recovered was deposited aqueously, as indicated by the presence of bivalves, gastropods and teleost fish remains (Table 1). Voorhies (1969) recorded that skull and mandible material are usually only moved by high-velocity currents, as they have a low surface area to volume ratio. However, as only a partial mandible has been recovered it is impossible to infer water current or movements.

Bone deterioration due to weathering is indicative of time elapsed between the death and final burial. Behrensmeyer, (1978) constructed a weathering scale based on the study of modern bones at Amboseli National Park (Kenya), which is characterised by a tropical, semi-arid climate, probably like that during Gurnard Member times. Therefore, the weathering scale estimated at Amboseli National Park can be applicable to this study. Behrensmeyer (1978) measured on a scale from 0 (not weathered) to 5 (extremely weathered), where each category relates to the number of years since death: Stage 0 (0-1 yr), Stage 1 (0-3 yr), Stage 2 (2-6 yr), Stage 3 (4-15 yr), stage 4 and Stage 5 (6-15 yr). With only superficial longitudinal cracking of the bone and no flaking of the outer surface, our specimens show a level of weathering consistent with stage 1.

Abrasion refers to erosion caused to bones by means of friction with sedimentary particles. To analyse abrasion, I have used the three stages proposed by Alcalá (1994): intact bone (Stage 1), rounded bone (Stage 2) and polished and smoothed bone (Stage 3). The abrasion stage can be used as a proxy for the either the intensity or length of time the bones interact with sediment particles. However, the degree of abrasion does not necessarily indicate distance of transport (Behrensmeyer, 1991). Examination of the bones shows that they are intact with no indication of erosion. The specimen has substantial pyrite growth within the bone structure which indicates that fossilisation occurred under anoxic conditions. This, in combination with little sign of abrasion, confirms rapid burial.

The specimen has breaks at the junction between the dentary and the anterior portion of the mandible containing the incisor / canine teeth, and between the dentary and the coronoid process. It is not usually possible to identify with certainty the agent of breakage. However, as the observed breakages are not spiral or saw-toothed fractures, they are unlikely to have occurred whilst the bones were fresh, and collagen rich. This makes it unlikely that the breakages were the result of postmortem trampling (Lyman, 1994). The breaks are therefore more likely to have occurred post fossilisation and probably happened when the bones were exposed to the action of the sea prior to discovery. Further examination of the bones also shows no indication of carnivoran or rodent activity. It can be inferred that the specimen was not exposed to weathering or abrasion for any extended period prior to burial. Combined with no evidence of postmortem damage by trampling or activity by carnivores or scavengers it is hypothesised that the bones were rapidly buried in a subaqueous, anoxic environment.

Conclusion

As finds from the Gurnard Member are typically fragmentary and found *ex-situ*, the palaeobiodiversity of the larger terrestrial mammals remains poorly known. Along with the paucity of detailed literature, identification can be difficult. Howgate Bay is not as rich in large fossil mammal remains as other Isle of Wight sites and has therefore historically not been so extensively studied. Moreover, Hooker (2010) noted that the majority of recorded large mammal finds appear to have come from the very top of the Gurnard Member which is eroded out at Howgate Bay. Historically poor recording of specimen locations does not preclude some fossils in museum collections as being from Howgate Bay. The find reported in this paper demonstrates that the lower

Gurnard Member in Howgate Bay does have rare identifiable mammal remains. Therefore, more focussed collecting from Howgate Bay should lead to the discovery of more *in-situ* finds which in turn will help refine our understanding of both the environment and palaeoecology of the site.

Acknowledgements: I would like to thank Martin Munt, Simon Penn, and the staff of the IWCMS for their support and access to comparative specimens, and to Jerry Hooker at the NHM for his advice and guidance.

References

Alcalá Martínez, L. 1994. *Macromamíferos neógenos de la fosa de Alfambra-Teruel*. Teruel: Instituto de Estudios Turolenses y Museo Nacional de Ciencias Naturales, CSIC. ISBN: 84-86982-46-4.

Allison, P. A., and Briggs, D.E.G., eds. 1991. Taphonomy, releasing the data locked in the fossil record. Plenum, New York.

Behrensmeyer, A.K. 1978. Taphonomic and ecologic information from bone weathering. *Paleobiology*; **4**(2):150-162.

Behrensmeyer, A.K. 1991. Terrestrial vertebrate accumulation. Pp. 291-335 in Allison and Briggs 1991.

Bhatia, S.B. 1955. The Foraminiferal Fauna of the Late Palaeogene Sediments of the Isle of Wight, England. Journal of Paleontology, **29**, (4), pp. 665–93.

Bonaparte, C. L. 1850. Conspectus Systematis Mastzoologiae. Editio altera reformata. *In: Conspectus Systematum*. Leiden, 4 charts.

Collinson, M.E. 1983. Palaeofloristic assemblages and palaeocology of the Lower Oligocene Bembridge Marls, Hampstead Ledge, Isle of Wight. *Botanical Journal of the Linnean Society*, **86**, 177-225.

Cuvier, G. 1804. Sur les espèces d'animaux dont proviennent les os fossiles répandus dans la pierre à plâtre des environs de Paris. *Annales du Muséum d'histoire naturalle*, Paris. **3**, 275-303, 364-387, 442-472.

Daley, B., 1972. Macroinvertebrate assemblages from the Bembridge Marls (Oligocene) of the Isle of Wight and their environmental significance. *Palaeogeography, Palaeoclimatology, Palaeoecology,* **11**. 11-31.

Daley, B., 1973a. Fluvio-laucustrine cyclotherms from the Oligocene of Hampshire. *Geological Magazine*, **110**, 235-242.

Daley, B., 1973b. The Palaeoenvironment of the Bembridge Marls (Oligocene) of the Isle of Wight, Hampshire. *Proceedings of the Geological Association*, **84**, 83-93.

Daley, B., 1990. The Bembridge Limestone (Late Eocene), Isle of Wight, southern England: a stratigraphical revision. *Tertiary Research*, **12**, 51-64.

Daley, B., Edwards, N., 1971. Palaeogene warping in the Isle of Wight. *Geological Magazine*, **108**, 5, 399-405

Daley, B., Edwards, N., 1974. week-end Field Meeting: Upper Eocene – Lower Oligocene beds of the Isle of Wight; report by the directors. *Proceedings of the Geological Association,* **85**, 281-292.

Daley, B., Edwards, N., 1990. The Bembridge Limestone (Late Eocene), Isle of Wight, southern England: a stratigraphical revision. *Tertiary Research*, **12**, 51-64.

Forbes, E., 1853. On the Fluvial-Marine Tertiaries of the Isle of Wight. *Quarterly Journal of the Geological Society of London*, **9**, 259-270.

Gale, A., 2019. The Isle of Wight: Geologists' Association Guide No 6. The Geologists' Association, London.

Gale, A., 2020. Acorn barnacles (Crustacea, Thoracica, Balanomorpha) from the Eocene and Oligocene of the Isle of Wight and Hampshire (United Kingdom) and Manche, northern France. *Acta Geologica Polonica,* **71**, 153-174.

Gale, A., 2021. Use of high-resolution stratigraphy and derived lithoclasts to document structural inversion: a case study from the Paleogene, Isle of Wight, UK. *Journal of the Geological Society* **178** (4).

Hooker, J, J., Collinson, M. E., Van Bergen, P.F., Singer, R.L., De Leeuw, J.W., & Jones, T.P. 1995. Reconstruction of land and freshwater palaeoenvironments near the Eocene-Oligocene boundary, southern England. *Journal of the Geological Society, London*, **152**, 449-468.

Hooker, J. J. 2010. The "Grande Coupure" in the Hampshire Basin, UK: taxonomy and stratigraphy of the mammals on either side of this major Paleogene faunal turnover. In Whittaker, J.E. & Hart, M. B. (eds) *Micropaleontology, Sedimentary Environments and Stratigraphy: A Tribute to Dennis Curry (1912-2001). Micropaleontological Society, Special Publications,* 147-215.

Hooker, J, J. 2021. The Mammals of the Late Eocene – Early Oligocene Solent Group. *Monographs of the Palaeontological Society*. ***175****(659), pp.1-147*.

Jèhenne, Y., and M. Brunet. 1992. Interêt biochronologique de quelques grands mammifêres ongules de l'Eocène supériieur et l'Oligocène d'Europe. *Géobios Mémoire Spécial*, **14**, 201-206.

Joomun, S.C., Hooker, J.J. and Collinson, M.E. 2008. Dental wear variation and implications for diet: an example from Eocene perissodactyls (Mammalia). *Palaeogeography, Palaeoclimatology, Palaeoecology*, **263**, 92-106.

Joomun, S.C., Hooker, J.J. and Collinson, M.E. 2010. Changes in Dental Wear of *Plagiolophus minor* (Mammalia: Perissodactyla) Across the Eocene-Oligocene Transition. Journal of Vertebrate Paleontology, **30**, 563-576.

Keen, M.C. 1977. Ostracod assemblages and the depositional environments of the Headon, Osborne and Bembridge Beds (upper Eocene) of the Hampshire Basin. *Palaeontology,* **20**, 405-445.

King, C. 2016 (edited by AS Gale and TL Barr). A revised correlation of Tertiary rocks in the British Isles and adjacent areas of NW Europe. *Geological Society, Special Report,* 27, 724pp.

Lyman, R. L. 1994. Vertebrate taphonomy. Cambridge University Press.

Owen, R. 1848b. Description of teeth and portions of jaws of two extinct Anthracotherioid quadrupeds discovered by the Marchioness of Hastings in the Eocene deposits of the NW coast of the Isle of Wight. *Quarterly Journal of the Geological Society of London*, **4**, 103-141.

Parrish, R.R., Parrish, C.M., and Lasalle,S. 2018. Vein calcite dating reveals Pyrenean orogen cause of Paleogene deformation in southern England. Journal of the Geological Society, London, **175**(3), 2017-107
Perales-Gogenola, L., Merceron, G., Badiola, A., Gómez-Olivencia, A., Pereda-Suberbiola X., 2022. The evolutionary ecology of the endemic European Eocene Plagiolophus (Mammalia: Perissodactyla). Palaeogeography, Palaeoclimatology, Palaeoecology, **594**.
Pomel, A. 1847. Note critique sur le genre *Paleotherium*. *Bulletin de la Societe geologique de France*, **4**, 584-587.
Remy J.-A., 2004. Le genre *Plagiolophus* (Palaeotheriidae, Perissodactyla, Mammalia): révision systématique, morphologie et histologie dentaires, anatomie crânienne, essai d'interprétation fonctionnelle. *Palaeovertebrata*, **33,** 17-281.
Voorhies, M. R., 1969, Taphonomy and population dynamics of the early Pliocene vertebrate fauna, Knox County, Nebraska. *Contributions to Geology, Special Paper No. 1. Laramie: University of Wyoming.*
Webster, T., 1814. On the freshwater formations in the Isle of Wight, with some observations on the strata over the chalk in the south-east part of England *Transactions of the Geological Society of London* S1, **2**, 161-254.
White, O.H.J., 1921. A short account of the geology of the Isle of Wight. *Memoir of the Geological Society of Great Britain.*
Wood, H. E. 1937. Perissodactyl suborders. *Journal of Mammalogy,* **18**. 106pp.

Author: Martyn C G Hornett
Volunteer at Dinosaur Isle Museum, Culver Parade, Sandown, Isle of Wight, PO36 8QA.
Email: hornettsnest@aol.com