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# Monitoring invertebrates in 2014 by finger searching and pitfall trapping after excavation of the surface vegetation in three slacks at Newborough Warren – Ynys Llanddwyn SSSI

RG Loxton

NRW Evidence Report No. 60

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Roedd y monitro a wnaed yn 2014 yn barhad o'r hyn a wnaed yn 2013 (Loxton, 2014), gydag archwilio â bysedd mewn llaciau cloddiedig 2, 3 a 4 a'r trapiau pydew yn Llac 4. Cafodd yr holl anifeiliaid di-asgwrn-cefn a ddalwyd yn y dosbarthiadau Orthoptera, Heteroptera, Auchenorrhyncha, Coleoptera, Aculeata, Diplopoda, Chilopoda, Araneae a Opiliones eu hadnabod a'u cyfrif. Cofnodwyd niferoedd y rhywogaethau unigol mewn tablau ar ôl eu cywiro am ymdrech trapio. Ychydig o dystiolaeth a gafwyd o unrhyw newid o 2013 yn yr anifeiliaid yn y cynefin twyni datgeledig. Yn y cynefin llaciau sydd wedi'i ddatguddio drwy gloddio, datgelwyd cynnydd sylweddol yn amlder y chwilen grwydr *Bledius subniger* drwy archwilio â bysedd a mapio dosbarthiad ei faw. Yn ogystal, datgelodd trapio pydew yn Llac 4 amlder y chwilod daear *Dyschirius impunctipennis* a *D. politus* sy'n hysbys fel ysglyfaethwyr o *B. subniger.* Yn ogystal, roedd chwilen ddaear arall, *Bembidion pallidipenne,* sy'n nodweddiadol o gynefin llaciau embryonig, yn niferus. Daethpwyd i'r casgliad yn betrus bod yr anifail hwn wedi cynyddu'n sylweddol, yn debygol oherwydd bridio yn 2013.

Rhoddir rhai sylwadau i ddangos y gogwydd sydd wrth hanfod trapiau pydew a'r perygl o gymharu amlder rhwng rhywogaethau sydd yn cael eu dal mewn trapiau pydew yn rhy hawdd. Ymddengys nad oedd cynnydd gweladwy yn rhywogaethau *Heterocerus* a *Dryops.* Roedd gan Lac 4 ddwy ardal eglur o gynefin llac a oedd wedi cael eu creu gan y cloddio. Yn y rhan ddeheuol, roedd cynnwys organig uwch yn y pridd a mwy o orchudd planhigion ac amrywiaeth. Roedd hyn yn gwrthgyferbynnu â'r rhan ogleddol a oedd gydag ond ychydig o orchudd planhigion a chynnwys organig isel yn y pridd. Roedd y gwahaniaethau hyn yn cael eu hadlewyrchu yn y gwahaniaeth sylweddol yn yr anifeiliaid yn y ddwy ardal. Roedd yr hanner ddeheuol yn cynnwys rhywogaethau a ddarganfuwyd yn y llaciau sydd heb eu cloddio a oedd yn ymddangos fel eu bod angen rhyw gymaint o gysgod, ond mae'n debyg eu bod wedi'u bwrw allan o'r llaciau cloddiedig eraill.

Hyd yma, mae saithallan o'r 16 rhywogaeth o chwilod a gofnodwyd yng Nghwningar Niwbwrch sy'n gysylltiedig â'r llaciau twyni arloesol wedi cael eu cofnodi o'r llaciau cloddiedig, sef y chwilod crwydr *Bledius longulus*, *Bledius subniger* a *Gabrius osseticus*, y chwilod daear *Dyschirius politus* a *Bembidion pallidipenne*, y *Dryops nitidulus* a'r *Heterocerus flexuosus*. Cafodd yr olaf ei ddarganfod yma am y tro cyntaf yn 2014, gyda'r pump arall yn cael eu cofnodi yn 2013 ac yn 2014 fel ei gilydd. Gyda *Dryops nitidulus* a *Gabrius osseticus* yn unig yn cael eu cofnodi yn Llac rheoledig 1, yn 2013, mae'n bosibl bod y rhywogaethau hyn yn cytrefu'r llaciau cloddiedig o bocedi gweddillion cynefin addas o fewn y system dwyni yn hytrach na chofnodion yn cynrychioli etifeddiaeth o boblogaethau sy'n bodoli o fewn y llaciau.

Mae ychwanegiadau newydd pwysig i anifeiliaid di-asgwrn-cefn Cwningar Niwbwrch yn cynnwys y chwilen *Leiodes longipes* a sboncyn y dail *Macrosteles quadripunctulatus*, y ddau wedi cael eu cofnodi am y tro cyntaf yng Nghymru.

Gwnaed rhai arsylwadau rhagarweiniol ar *Bledius subniger* a oedd yn awgrymu bod y rhywogaeth yn fywiog ac yn bridio o fis Ebrill tan ddiwedd mis Medi ac mae'n debyg ei fod yn treulio'r gaeaf fel oedolyn. Mae'r rhywogaeth yn symud ymhellach i mewn i'r llaciau fel y maen nhw'n sychu, ond ymddengys nad yw'n gallu cytrefu arwynebau gyda haen drom o alga wedi sychu o'r genws *Zygnema*.

## 2. Executive Summary

The monitoring carried out in 2014 continued that undertaken in 2013 (Loxton, 2014), with finger searching in excavated slacks 2, 3 & 4 and pitfall trapping in Slack 4. All invertebrates captured in the taxa Orthoptera, Heteroptera, Auchenorrhyncha, Coleoptera, Aculeata, Diplopoda, Chilopoda, Araneae and Opiliones were identified and counted. The numbers of the individual species are recorded in tables after being corrected for trapping effort. There was little evidence of any change from 2013 in the fauna on the exposed dune habitat. In the slack habitat exposed by excavation, a marked increase in the abundance of the rove beetle *Bledius subniger* was revealed by finger searching and mapping the distribution of its casts. Pitfall trapping in Slack 4 also revealed the abundance of the ground beetles *Dyschirius impunctipennis* and *D. politus* that are known predators of *B. subniger.* Another ground beetle, *Bembidion pallidipenne,* characteristic of embryonic slack habitat, was also abundant. It is tentatively concluded that this fauna has greatly increased, probably from breeding in 2013.

Some observations are given to illustrate the bias inherent in pitfall trapping and the danger of too easily comparing abundance between species that are caught in pitfalls. There seemed to be no detectable increase in species of *Heterocerus* and *Dryops.* Slack 4 had two distinct areas of slack habitat that had been created by the excavation. In the southern part, there was a higher organic content in the soil and greater plant cover and diversity. This contrasted with the northern part which had little plant cover and a low organic content in the soil. These differences were reflected in a marked difference in the fauna of the two areas. The southern half contained species found in the unexcavated slacks that appear to require some shade but were probably eliminated from the other excavated slacks.

To date, sevenof the 16 beetle species recorded from Newborough Warren that are associated with pioneer dune slacks have been recorded from the excavated slacks, namely the rove beetles *Bledius longulus*, *Bledius subniger* and *Gabrius osseticus*, the ground beetles *Dyschirius politus* and *Bembidion pallidipenne*, and *Dryops nitidulus* and *Heterocerus flexuosus*. The latter was first found here in 2014, with the other five being recorded in both 2013 and 2014. With only *Dryops nitidulus* and *Gabrius osseticus* recorded from the control Slack 1, in 2013, it is possible that these species are colonising the excavated slacks from remnant pockets of suitable habitat within the dune system rather than records representing a legacy of existing populations within the slacks.

Important new additions to the Newborough Warren invertebrate fauna include the the beetle *Leiodes longipes* and the leafhopper *Macrosteles quadripunctulatus*, both of which were recorded for the first time in Wales.

Some preliminary observations were made on *Bledius subniger* suggesting the species is active and breeding from April to the end of September and probably over-winters as an adult. The species moves further into the slacks as they dry out but it appears to be unable to colonise surfaces heavily coated with dried out alga of the genus *Zygnema.*

# 3. Introduction

In 2013 a pitfall survey of two of three excavated slacks was carried out and compared with an adjacent untreated slack that acted as a control (Loxton, 2014). The unexcavated slack was referred to as the 'Control Slack' and the two excavated slacks as 'Experimental Slacks 1 & 2'. However it seems that staff members of NRW refer to these slacks more simply as Slacks 1 (my 'Control Slack'), 2, 3 (my 'Experimental Slacks') and 4 (the small excavated slack nearer the coast). I shall defer to this nomenclature for ease of communication. For background to this monitoring and intervention, see Loxton (2014). It is sufficient to say here that this intervention by excavation, by what was then the Countryside Council for Wales, was prompted by the realisation that bare sand and pioneer conditions had declined by more than 90% on Newborough Warren between the 1940s and 2009 (Pye & Blott, 2012), with embryonic slack habitat almost completely lost (Bratton, 2012), with the increased vegetation of the dunes and slacks together with a lack of mobile sand from the beach. The excavated slacks can be seen in Photo 1, Appendix 1.

The monitoring in 2013 had shown that the excavations had decreased the abundance and variety of invertebrates in Slacks 2 & 3 compared to Slack 1 but there were clear signs of the presence, if not colonisation, of the excavated slack habitat by some of the expected specialist species characteristic of embryonic slack habitat. These included the ground beetles (Carabidae) *Bembidion pallidipenne* and *Dyschirius politus*, the rove beetles (Staphylinidae) *Bledius subniger* and *Gabrius osseticus* and the long-toed water beetle *Dryops nitidulus*. There was little detectable sign of any colonisation of the excavated dune habitat by species favouring yellow sand habitat.

The labour involved in pitfall trapping did not seem to warrant a full repetition in 2014 of that carried out in 2013 and monitoring of Slacks 2 & 3 was limited to finger searching for fixed periods of time. However the more seaward Slack 4 had not been previously monitored at all, and in 2014 pitfall trapping was carried out here with some additional finger searching. Slack 4 had two distinct areas of slack habitat that had been created by the excavation. In the southern part, there was a higher organic content in the soil and greater plant cover and diversity, the 'Organic Slack'. This contrasted with the northern part which had little plant cover and a low organic content in the soil, the 'Mineral Slack'.

As well as monitoring the invertebrates, the author assisted Dr Laurence Jones of CEH in installing six $2m^2$ plots in each of the excavated slacks in the slack habitat. The positions of these plots were accurately recorded and Dr Jones recorded the % cover of the plant species in these plots, took soil samples, photographed the vegetation and arranged for the recording of the water table in these slacks (Jones & Loxton, 2015). This work was done on 1st and 2nd July. Dr Jones also most kindly measured for me the pH and organic content of some soil samples from areas where the burrows of *Bledius subniger* were abundant.

*Bledius subniger* was easy to detect from the sand casts made by their burrowing in the excavated slacks and I made an attempt to map the beetle's distribution in Slack 2. I also tried a possible method of objectively sampling this species using a shallow

soil core. A simple observation was made to demonstrate the difference in numbers obtained by pitfall trapping and finger searching for this species and its predators. This was done by counting the numbers of *Bledius* and *Dyschirius* beetles found in the 'Mineral Slack' in Slack 4 during a finger search of one hour on 24th and then again on 26th July and comparing the sum of these with the numbers taken in the nearby pitfalls in the same habitat between 21st and 29th July. When reporting these results I will also record Dr Jones' measurements of the pH and organic content of the habitat of *Bledius subniger*.

In addition to reporting on the monitoring of these excavated slacks, this account includes five appendices concerning photographic images, the details of Heteroptera and Auchenorrhyncha collected in 2013, new invertebrate records for Newborough Warren, invasive plants and possible corvid control with respect to breeding lapwings.

## 4. Methods

Pitfall trapping in Slack 4 was carried out as in 2013. Four lines of five traps, two in the slack and two on the dunes, were installed on 29th April and run continuously till 29th July and then again from 1st September to 24th October. Traps on the dune were placed either side about half way up the dune on the north-western side of the slack. One line was installed on each side of the dune. This bare dune area was created by the sand removed in excavation of the slack. This bare sand can be seen in Photo 1 (taken early in 2013 soon after excavation) in the south western corner of Slack 4. This dune area had been colonised by a vigorous stand of Creeping Thistle *Cirsium arvense* and some large plants of Common Ragwort *Senecio jacobaea* (Photo 2). Earlier in the year, there was more bare sand (Photo 3). Other plants that grew vigorously here were Oxeye Daisy, Dune Pansy and Dewberry. Two further lines of five traps were placed in the slack habitat.

The excavated area of the slack here was different from that created in Slacks 2 & 3. In the southern half of Slack 4 the sand surface was dark with an apparently higher organic content and much greater plant cover and diversity ('Organic Slack'). Anyone interested in the details of the plant cover should consult either Jones & Loxton (2015) or the files prepared by Dr Jones and held by Graham Williams of NRW. The northern half more closely resembled the excavated areas of the other treated slacks with little remaining vegetation and a surface of yellow sand ('Mineral Slack'). Images of these areas can be found in Appendix A, Photos 4, 5 & 6. Graham Williams tells me that when Slack 4 was excavated the contractors were unable to make a clean job of removing the soil surface due to the amount of flood water present. The soil being excavated became a liquid suspension, spreading organic matter, and no doubt seed, over the southern half of the slack. Before excavation of Slack 4 there was a shallow pond, made to provide drinking water for ponies, that persists as a deeper area towards the north-eastern end of the 'Organic Slack'. Much of the present vegetation of the 'Organic Slack' including plants such as Jointed Rush, Water Mint, Common Marsh Bedstraw, Brook Weed and Blue Water Speedwell probably originated from the edge of this pond.

The location of the mid-points of these pitfall trapping lines were as follows:

| | |
|---|---|
| Mineral Slack | SH4215-6281- |
| Organic Slack | SH4214-6278- |
| South-east Dune | SH4210-6275- |
| North- west Dune | SH4209-6272- |

As in 2013, there was disturbance of the pitfall traps by drifting sand and by the ponies. To correct for different trapping effort in each of the four habitats the total catch for each species was summed for each of the four habitats divided by the number of effective trap nights and then multiplied by 700 to give the total number of invertebrates of each species caught in 700 trap nights. The figure of 700 was chosen so as to give a figure of approximately 1 where one insect was caught in the habitat with the least trap disturbance.

The number of effective trap nights in the four habitats were:

| | |
|---|---|
| 'Mineral' Slack | 652 |
| 'Organic' Slack | 703 |
| S-E Dune | 607 |
| N-W Dune | 516 |

Finger sampling in Slacks 2 & 3 was carried out by searching the ground and using the blade of a penknife to investigate any possible burrowing in the sand surface. Individual searching episodes were limited to one hour periods in a slack, either on the excavated dune or the slack surface. However, on the 16th June, three separate visits of an hour long were made to Slack 2. When sampling the slack surfaces, half the sampling period was spent in the drier parts of the slack and half in the wetter areas. The numbers of invertebrates found in the two half hour periods were summed in this report but reference to differences between the two areas are made in this account. I have included some data from Slack 4 which were made as part of the study of *Bledius subniger*. Some attempt was also made to finger search the dune habitat in Slacks 2 & 3 but this was not productive. The sand was still very mobile and presumably inhospitable to most invertebrates. There seemed little to gain in putting much effort into this sampling of the dune habitat. Attempts were made to search the dune and slack surfaces at night but this was again unproductive and no useful results were obtained, but it might be expected that as the biological succession on the dune surface matures this might become more profitable. One of the problems of visiting these slacks was the presence of a breeding pair of lapwings with their chicks in Slacks 2 or 3 (see Appendix D). I was reluctant to disturb these birds and often felt it necessary to abandon sampling - this even happened on a night visit.

The dates and durations of sampling are set out below in Table 1. The total numbers of individual species are summed by habitat sample in the results.

Table 1. Hours spent finger searching in Slacks 2 & 3.

| Slack 2 Slack | Hours | Slack 2 Dune | Hours | Slack 3 Slack | Hours | Slack 4 Slack | Hours |
|---|---|---|---|---|---|---|---|
| 30-May | 1 | 20-Jun | 1 | 30-May | 1 | 24 July | 1 |
| 16-Jun | 3 | 24-Jun | 0.5 | 15-Jun | 1 | 26 July | 1 |
| 24-Jun | 1 | | | 07-Jul | 1 | | |
| 09-Jul | 0.5 | | | 21-Jul | 1 | | |
| 21-Jul | 1 | | | 24-Aug | 1 | | |
| 23-Aug | 1 | | | 17-Sep | 1 | | |
| 17-Sep | 1 | | | | | | |
| Total Hours | 8.5 | | 1.5 | | 6 | | 2 |

A small preliminary study of the habitat of *Bledius subniger* included taking soil samples to a depth of 2cm (I have never found this beetle deeper in the soil and always within about 1cm of the soil surface). The pH of these samples, taken on the 19th September, was determined by Dr Jones and he also estimated the percentage organic content by measuring the loss in weight of a dried sample after ignition at 375ºC. I also attempted to explore the possibility of quantitative sampling of *Bledius subniger* by taking soil cores with a bulb planter, diameter 6cm, to an approximate depth of 4cm giving a sample volume of about 110cc. These samples were then mixed with water on a white tray and gently agitated. Most samples contained little organic matter so that the beetles floated to the surface and could be easily counted or collected. Using this method some data were collected in Slack 2 on 19th September in different parts of the excavated slack. This slack had areas where the surface had a thick crust of dried fibrous alga – kindly identified for me by Dr Geraldine Reid of Liverpool Museum as a species of *Zygnema*. There were also areas of almost bare sand and a more thickly vegetated area in the lowest area of the slack.

The excavated slack surface when closely examined is less uniform than one might expect from an initial viewing. I also attempted to map the distribution of *Bledius subniger* in Slack 2 on 16th and 19th of June. This was done by walking the slack and noting the presence of the casts thrown up by the burrowing activity of the beetle. These show up as irregular heaps of dried sand against the darker, damp surface of the soil (Photo 7). A map was constructed using an enlargement of the aerial photograph from which a tracing was made and scanned. This image was used to map the slack on the ground, mapping the different wetter and drier areas and the presence or absence of casts. It would be much more satisfactory to use an accurately surveyed mapping system using a grid of reference points but as a preliminary investigation this serves to illustrate a few points concerning the beetle's ecology and the slack habitat or habitats created by the excavation.

It became apparent that the number of *Bledius subniger* caught in pitfalls was small compared to the *Dyschirius* predators. A simple observation was made to demonstrate that this imbalance was probably a reflection of bias in the pitfall sampling. The number of beetles caught in five pitfalls between 21st and 29th July in Slack 4 was compared to the beetles caught in two sessions of finger searching close to the pitfall traps, each session being of one hour, on 24th and 26th July.

# 5. Results

## 5.1. Pitfall trapping in Slack 4

The number of invertebrates for each species, adjusted for trapping effort, that were caught in the pitfalls is given in Tables 2-5. These tables are rather long, not easy to digest and contain many records of species represented by only one or two individuals – they might be said to bear witness to taxonomic effort rather than to biological insight. Probably some species were caught as immigrants and are not resident constituents of the fauna or are specialist feeders such as the dung beetles *Onthophagus* and *Aphodius* (Scarabaeidae) utilising the horse dung. Others are common and widespread species of little interest here with respect to the fauna of embryonic slacks and yellow dune. To help the reader I have highlighted in bold, blue type the species that seem of interest and my comments will be largely limited to these species. At the bottom of each table the totals for species and individuals caught is given. The species are listed by families (bold type). Species in bold, red type are Grade 1 to 3 pioneer dune slack species, as identified by NRW invertebrate specialists.

Table 2. Adjusted numbers of Coleoptera taken in pitfall traps.

| | Mineral Slack | Organic Slack | Dune E/S | Dune W/N |
|---|---|---|---|---|
| **Dytiscidae** | | | | |
| *Agabus nebulosus* | 2.1 | 5.0 | | |
| **Carabidae** | | | | |
| *Leistus terminatus* | | | | 1.4 |
| ***Nebria brevicollis*** | **2.1** | **23.9** | | **1.4** |
| ***N. salina*** | **1.1** | **16.9** | **1.2** | **1.4** |
| ***Elaphrus riparius*** | **9.7** | **53.8** | | |
| *Loricera pilicornis* | | 9.0 | | |
| *Dyschirius globosus* | 1.1 | 6.0 | | |
| ***D. impunctipennis*** | **223.3** | **12.9** | | |
| ***D. politus*** | **67.6** | **14.9** | | |
| ***Bembidion pallidipenne*** | **149.2** | **6.0** | | |
| ***B. saxatile*** | **2.1** | **9.0** | | |
| *B. quadrimaculatum* | | 1.0 | 1.2 | |
| ***Pterostichus niger*** | | **14.9** | | |
| *P. strennuus* | | 3.0 | | 1.4 |
| ***Calathus cinctus*** | | | **3.5** | **2.7** |
| ***C. erratus*** | | | **11.5** | **6.8** |
| ***C. fuscipes*** | **4.3** | **106.5** | **27.7** | **14.9** |
| ***C. melanocephalus*** | **3.2** | | **19.6** | **10.9** |
| ***C. mollis*** | | | **10.4** | **23.1** |
| ***Agonum marginatum*** | **7.5** | **308.7** | | |
| *A. mulleri* | | 4.0 | | |
| *Amara bifrons* | | | 2.3 | 1.4 |
| *A. lucida* | | | | 1.4 |
| *Harpalus affinis* | | | 1.2 | |
| ***H. anxius*** | **1.1** | | **48.4** | |
| *H. neglectus* | | | | 1.4 |
| *H. rubripes* | | | 1.2 | 1.4 |

| | | | | |
|---|---|---|---|---|
| ***Harpalus tardus*** | **1.1** | | **13.8** | **1.4** |
| *Anisodactylus binotatus* | | 1.0 | | |
| ***Syntomus foveatus*** | **1.1** | | **2.3** | **6.8** |
| **Helophoridae** | | | | |
| *Helophorus aequalis* | | 3.0 | | |
| *Helophorus alternans* | 1.1 | | | |
| *H. brevipalpis* | 1.1 | 6.0 | 1.2 | 1.4 |
| **Hydrophilidae** | | | | |
| *Megasternum concinnum* | | | | 1.4 |
| **Leiodidae** | | | | 0.0 |
| *Catops fuliginosus* | | | 1.2 | |
| *Leiodes calcarata* | 2.1 | 7.0 | | |
| *L. longipes* | | 1.0 | | |
| *L. rufipennis* | | 14.9 | | |
| **Silphidae** | | | | |
| *Silpha atrata* | | | 1.2 | |
| *Nicrophorus vespillo* | | 1.0 | | |
| **Staphylinidae** | | | | |
| *Lesteva longoelytra* | | | | 1.4 |
| *Micropeplus staphylinoides* | | | 1.2 | |
| *Pselaphus heisei* | 1.1 | 1.0 | | |
| *Sepedophilus nigripennis* | | 2.0 | | |
| *Tachyporus obtusus* | | | 4.6 | 1.4 |
| *T. dispar* | | | 2.3 | |
| *T. nitidulus* | | | 11.5 | 8.1 |
| *T. solutus* | | 1.0 | | |
| *Aleochara bipustulata* | | 1.0 | 5.8 | 8.1 |
| *Aloconota gregaria* | | 22.9 | 1.2 | |
| *Mocyta fungi* | | 2.0 | | 6.8 |
| *Drusilla canaliculata* | 1.1 | 1.0 | | 1.4 |
| *Pella limbata* | 1.1 | | 1.2 | |
| *Anotylus rugosus* | | 1.0 | | 6.8 |
| *Carpelimus rivularis* | | 1.0 | | |
| ***Bledius subniger*** | **91.3** | | **4.6** | |
| ***Bledius gallicus*** | | **42.8** | **1.2** | |
| *Stenus canaliculatus* | | 2.0 | | |
| *Stenus clavicornis* | | | 2.3 | 2.7 |
| *S. comma* | | 1.0 | | |
| *S. nigritulus* | | | 1.2 | |
| ***Gabrius osseticus*** | **5.4** | **9.0** | **6.9** | **6.8** |
| *G. exiguus* | **1.1** | | | |
| *Othius laeviusculus* | 2.1 | 1.0 | | 1.4 |
| *O. punctulatus* | | | | 1.4 |
| *Philonthus carbonarius* | 1.1 | 4.0 | | |
| *P. cognatus* | | 2.0 | | |
| *Quedius ?fulgidus* | | 1.0 | | |
| *Q. levicollis* | | 2.0 | 1.2 | 1.4 |
| *Q. molochinus* | 1.1 | | | |
| *Q. schatzmayri* | | 2.0 | | |
| *Q. semiobscurus* | | 2.0 | | |
| *Ocypus brunnipes* | 2.1 | 1.0 | 5.8 | |

| | | | | |
|---|---|---|---|---|
| *O. olens* | | | 4.6 | 1.4 |
| *O. aenocephalus* | 2.1 | 12.9 | 0.0 | 1.4 |
| *Tasgius ater* | 1.1 | | 1.2 | |
| *Xantholinus linearis* | 1.1 | 1.0 | | |
| *X. longiventris* | 1.1 | | 1.2 | 1.4 |
| **Scarabeidae** | | | | |
| *Onthophagus coenobita* | 1.1 | | | |
| *O. similis* | 5.4 | 6.0 | 8.1 | 1.4 |
| *Aphodius contaminatus* | 3.2 | | 1.2 | |
| *A. merdarius* | 1.1 | | | |
| ***A. plagiatus*** | | **2.0** | | |
| *Sericea brunnea* | 2.1 | | 2.3 | 8.1 |
| *Hoplia philonthus* | 1.1 | 1.0 | | |
| *Philopertha horticola* | | | 1.2 | |
| **Scirtidae** | | | | |
| *Cyphon hilaris* | | | 1.2 | |
| **Byrrhidae** | | | | |
| *Simplocaria semistriata* | | 1.0 | 1.2 | |
| *Cytilus sericeus* | | 1.0 | | |
| **Dryopidae** | | | | |
| ***Dryops nitidulus*** | **1.1** | **2.0** | | |
| *D. ernesti* | | 4.0 | | |
| **Heterocidae** | | | | |
| ***Heteroceros flexuosus*** | | **1.0** | | |
| **Elateridae** | | | | |
| *Agrypnus murinus* | 8.6 | 12.9 | 20.8 | 14.9 |
| *Adrastus pallens* | | | 1.2 | 1.4 |
| *Agriotes lineatus* | 2.1 | 4.0 | | |
| *Cardiophorus asellus* | 3.2 | 1.0 | | 2.7 |
| **Lampyridae** | | | | |
| *Lampyris noctiluca* | | 1.0 | 3.5 | |
| **Cantharidae** | | | | |
| *Cantharis nigricans* | | 2.0 | 1.2 | |
| *Rhagonycha fulva* | | | 2.3 | |
| **Nitidulidae** | | | | |
| *Meligethes aeneus* | | | 1.2 | 1.4 |
| **Phalacridae** | | | | |
| *Olibrus affinis* | | | 9.2 | 2.7 |
| **Coccinellidae** | | | | |
| *Coccinella 11-punctata* | 1.1 | 14.9 | 15.0 | 1.4 |
| *C. 7-punctata* | 1.1 | | 8.1 | 1.4 |
| *Scymnus frontalis* | | | 1.2 | |
| *Rhizobius litura* | | | 3.5 | 1.4 |
| **Latridiidae** | | | | |
| *Enicmus histrio* | | | 1.2 | |
| *E. ?fungicola* | | | | 1.4 |
| **Cerylonidae** | | | | |
| *Cerylon ferrugineus* | | | | 1.4 |
| **Tenebrionidae** | | | | |
| *Phylan gibbus* | | | 1.2 | |
| *Melanimon tibialis* | 1.1 | | | |

| | | | | |
|---|---|---|---|---|
| *Isomira murina* | 3.2 | | | |
| *Cteniopus sulphureus* | | 2.0 | | |
| *Lagria hirta* | | | 2.3 | |
| **Chrysomelidae** | | | | |
| *Phyllotreta undulata* | 1.1 | | | |
| *Sermylassa halensis* | 2.1 | 1.0 | | |
| ***Neocrepidodera ferruginea*** | | **20.9** | **53.0** | **27.1** |
| *N. transversa* | 1.1 | | | |
| *Longitarsus atricillus* | | 1.0 | | |
| *L. fulvicollis* | | 2.0 | | |
| *L. jacobaea* | 3.2 | 4.0 | 6.9 | |
| *L. luridus* | | | | 1.4 |
| *Psyloides napi* | | | 1.2 | |
| *Cassida rubiginosa* | | | 1.2 | |
| **Apionidae** | | | | |
| *Ceratapion onopordi* | | | | 5.4 |
| *Ischopterapion loti* | | | 3.5 | |
| *Protapion fulvipes* | | | 1.2 | 1.4 |
| *P. ononidis* | | | 11.5 | 1.4 |
| **Curculionidae** | | | | |
| *Glocianus punctiger* | | | 1.2 | |
| *Trichosirocalus troglodytes* | | | 1.2 | |
| *Rhinoncus pericarpius* | | | 2.3 | |
| ***Philopedon plagiatus*** | **25.8** | **9.0** | **173.0** | **169.6** |
| ***Otiorhynchus ovatus*** | **1.1** | | **26.5** | **25.8** |
| ***Charagmus griseus*** | **1.1** | | **23.1** | **6.8** |
| *Sitona cambricus* | | 1.0 | | |
| *Sitona lepidus* | 8.6 | | | |
| ***S. lineatus*** | | **19.9** | | **5.4** |
| ***S. lineelus*** | | | **16.1** | |
| *S. sulcifrons* | 1.1 | | | |
| *Hypera nigrirostris* | 0.0 | | 3.5 | |
| *H. plantaginis* | 1.1 | | 2.3 | |
| *H. zoilus* | | | 1.2 | 1.4 |
| *Orobitis cyanea* | | | | 1.4 |
| **Number of beetles** | **675.3** | **860.3** | **620.4** | **417.8** |
| **Number of species of beetle** | **56** | **69** | **70** | **55** |

A total of 141 species of beetle was recorded. In fact there were probably about another six species of the difficult to identify aleocharine rove beetles. These tend to be small and are damaged in the traps, and in sieving and washing the samples. The material has been preserved and will be eventually processed. However these make little difference to the overall picture as few individuals were caught.

The difference between the ‘organic’ and ‘mineral’ parts of the slack is marked. There were more species and individual beetles caught in the ‘organic’ part. Although many species occurred in both parts of the slack many were markedly more numerous in the ‘organic’ part. These include the ground beetles *Nebria brevicollis, Nebria salina, Elaphrus riparius, Bembidion saxatile, Pterostichus niger, Calathus fuscipes* and *Agonum marginatum,* and among the rove beetles *Bledius gallicus* and perhaps

*Gabrius osseticus* though in the latter case the difference is slight. *Bembidion saxatile* is of interest as it has not been recorded at Newborough since 1950-52 and may not have been found then on the Newborough dunes (see Appendix C). It is a species found on sand or gravel near water, especially on the coast (Luff, 2007). *Bembidion saxatile* may have been living at the edges of the small ponds made on the dunes and the excavation has expanded its habitat and attracted observers! The leaf beetle *Neocrepidodera ferruginea* and the weevil *Sitona lineatus* are also numerous in the 'organic' part of the slack and apparently absent in the 'mineral' part – perhaps unsurprising given the paucity of plants in the 'mineral' part of the slack. Although it is probable that surface running insects are more likely to be trapped where the surface is unimpeded with plants (as in the mineral slack) it seems reasonable to assume that if a species is more common in the area with denser plant growth this reflects a real difference in abundance. Several of the species mentioned above such as *Nebria brevicollis* and *Pterostichus niger* are usually associated with habitats providing a degree of shade and are found in woodlands. A notable absentee was the ground beetle *Poecilus versicolor*. This is the most numerous species of ground beetle taken in undisturbed slacks (Loxton, 2014).

However there is a group of species that are much more common in the 'mineral' slack than in the 'organic part – *Dyschirius impunctipennis*, *Dyschirius politus*, *Bembidion pallidipenne* and *Bledius subniger.* These are all associated with, and characteristic of, embryonic slack habitat (although *Dyschirius impunctipennis* is currently classified as a strandline species by NRW). It is an adventitious by-product of the excavation in this slack that it has provided us with a direct and adjacent comparison of embryonic slack habitat with a slack habitat of a more mature stage in the plant succession – even if artificially created. The differences in the beetle faunas are marked. It is interesting perhaps to note that only in the 'organic' slack was *Aphodius plagiatus* found although only two were taken. This is a species that feeds on fungi as an adult, and as a larva on organic material in the soil (Loxton, 1966). It is unlikely to be resident in embryonic slack habitat with a soil of low organic content and it will be interesting to see if this species becomes more numerous in Slack 4 and the other excavated slacks as the vegetation matures. In the 1960s when the slack habitat at Newborough was much more open this was an abundant species.

There are of course marked differences between the slack and dune faunas with the ground beetles *Calathus cinctus, Calathus melanocephalus, Calathus mollis, Harpalus anxius, Harpalus tardus* and *Syntomus foveatus* either exclusively on the dunes or much commoner there. The weevils *Philopedon plagiatus* and *Charagmus griseus* are confined to dunes, and *Otiorhynchus ovatus* and *Sitona lineelus* are most often encountered on dunes. However, two tenebrionids *Phylan gibbus* and *Melanimon tibialis* were represented by only a single specimen in each case. These two species are common and numerous species of grey dune and as in 2013 have not been found commonly where the dune surface has been reduced to bare sand. There is, as in 2013, as yet no sign of species such as *Broscus cephalotes, Xanthomus pallidus* or *Anthicus bimaculatus* that we might expect to colonise these areas of bare sand habitat.

Table 3. Adjusted numbers of Hemiptera taken in pitfall traps.

| | Mineral Slack | Organic Slack | Dune E/S | Dune W/N |
|---|---|---|---|---|
| **HETEROPTERA** | | | | |
| **Saldidae** | | | | |
| ***Saldula saltatoria*** | **12.9** | **258.9** | **1.2** | |
| **Tingidae** | | | | |
| *Acalypta parvula* | 4.3 | 1.0 | | 1.4 |
| **Miridae** | | | | |
| *Macrotylus paykulli* | | | 4.6 | |
| **Anthocoridae** | | | | |
| *Anthocoris nemoralis* | | | | 1.4 |
| *A. nemorum* | | | | 9.5 |
| **Lygaeidae** | | | | |
| ***Cymus claviculus*** | **1.1** | **4.0** | **1.2** | |
| *Drymus sylvaticus* | | | 2.3 | |
| *Trapezonotus arenarius* | | | 2.3 | |
| *Plinthisus brevipennis* | | | | 2.7 |
| **Berytidae** | | | | |
| *Berytinus signoreti* | | 1.0 | | |
| *Gampsocoris punctipes* | | | 5.8 | |
| **Thyreocoridae** | | | | |
| *Thyreocoris scarabaeoides* | | | 1.2 | |
| **Pentatomidae** | | | | |
| *Picromerus bidens* | | | 1.2 | |
| *Dolycoris baccarum* | | | 6.9 | 4.1 |
| **AUCHENORRHYNCHA** | | | | |
| **Cicadellidae** | | | | |
| *Philaenus spumarius* | | 2.0 | 4.6 | 6.8 |
| *Megophthalmus scabripennis* | | 1.0 | 10.4 | |
| *Evacanthus interuptus* | | | | 1.4 |
| ***Anaceratogallia frisia*** | **5.4** | **1.0** | **41.5** | **9.5** |
| ***A. laevis*** | | | **1.2** | |
| *Aphrodes ?diminuta* | | 1.0 | | |
| ***A. bicincta*** | | | **11.5** | |
| *Anascopus albifrons* | | | 1.2 | |
| *Acrocephalus punctum* | | 1.0 | | |
| *Verdanus abdominalis* | | | 1.2 | |
| ***Psammotettix sabulicola*** | | **3.0** | **40.4** | **48.8** |
| ***P. nodosus*** | | | **20.8** | |
| *Psammotettix confinis* | | 5.0 | | |
| *Euscelis incisus* | | 2.0 | 1.2 | 1.4 |
| *Mocydiopsis attenuata* | | | 2.3 | |
| ***Macrosteles horvathi*** | **35.4** | **43.8** | | |
| *M. laevis* | | 1.0 | | |
| *M. quadripunctulatus* | 1.1 | | | |
| *M. ?sexnotatus* | 1.1 | | | |
| *Eupteryx notata* | | | 1.2 | |
| *E. vittata* | | 1.0 | | 1.4 |
| **Delphacidae** | | | | |
| *Conomelus anceps* | | | | 1.4 |

| | | | | |
|---|---|---|---|---|
| *Criomorphus albomarginatus* | 1.1 | | | |
| *Javesella pellucida* | 1.1 | | | |
| *Muirodelphax aubei* | | | 2.3 | |
| **Number of bugs** | **45.1** | **61.7** | **139.5** | **70.5** |
| **Number of species of bugs** | **6.0** | **11.0** | **13.0** | **7.0** |

39 species of bugs were found including a single male of a rare species, *Macrosteles quadripunctulatus* – this was taken in the 'mineral' slack. From what little is known of this species (see Appendix C) it is likely that the 'mineral' slack resembles its natural habitat especially when dried out in the summer. *Saldula saltatoria* was abundant in the organic part of the slack and probably also *Cymus claviculus* – the latter species feeds on some species of *Juncus* including Jointed Rush, which is common here. *Macrosteles horvathi* is the only other numerous species in the slack occurring in both the 'mineral' and 'organic' slack. On the dunes as opposed to the slack the most numerous species are *Anaceratogallia frisia*, *Aphrodes bicincta*, *Psammotettix sabulicola* and *Psammotettix nodosus. Anaceratogallia frisia,* only recently recognised as occurring in Britain, was much more numerous in the pitfalls than the closely related *Anaceratogallia laevis*, as has been found on other Welsh dunes – see Appendix C. *Psammotettix nodosus* is not a common species (see Appendix C) and is probably a species associated with dry grasslands.

Table 4. Adjusted numbers of Araneae and Opiliones taken in pitfall traps.

| | Mineral Slack | Organic Slack | Dune E/S | Dune W/N |
|---|---|---|---|---|
| **ARANEAE** | | | | |
| **Theridiidae** | | | | |
| *Enoplognatha ovata* | | | 2.0 | |
| **Linyphiidae** | | | | |
| *Walckenaeria vigilax* | 2.1 | | | |
| *Gnathonarium dentatum* | | 3.0 | | |
| *Pocadicnemis pumila* | 1.1 | | | |
| *Oedothorax gibbosus* | | 1.5 | | |
| ***O. fuscus*** | **131.0** | **500.2** | **17.9** | **16.7** |
| ***O. retusus*** | **3.2** | **31.1** | | |
| ***Mecopisthes peusi*** | | | **2.0** | |
| *Troxochrus scabriculus* | | 1.5 | 2.0 | |
| *Minyriolus pusillus* | 1.1 | 1.5 | | |
| *Monocephalus fuscipes* | | 1.5 | | |
| *Micrargus subaequalis* | | 1.5 | | |
| *Araeoncus crassiceps* | | 1.5 | | |
| *Milleriana inerrans* | 4.3 | 3.0 | 2.0 | |
| ***Erigone dentipalpis*** | **31.1** | **201.3** | **13.9** | |
| ***E. atra*** | **22.5** | **167.2** | **2.0** | |
| ***E. longipalpis*** | **5.4** | **3.0** | | |
| *Ostearius melanopygius* | | | 2.0 | |
| *Agyneta subtilis* | | | 2.0 | |
| *Centromerita concinna* | 3.2 | | | 5.6 |
| *Bathyphantes gracilis* | | 1.5 | | |
| *Lepthyphantes tenuis* | 2.1 | 1.5 | 17.9 | 8.4 |
| *L. zimmerana* | | | 4.0 | 8.4 |

| | | | | |
|---|---|---|---|---|
| *L. pallidus* | 1.1 | | | |
| **Tetragnathidae** | | | | |
| *Pachygnatha clercki* | | 1.5 | | |
| ***P. degeeri*** | **3.2** | **11.8** | | |
| **Araneidae** | | | | |
| *Larinioides cornutus* | | | | 2.8 |
| **Lycosidae** | | | | |
| ***Pardosa monticola*** | **11.8** | **153.9** | **19.9** | **11.2** |
| *P. palustris* | | 1.5 | | |
| *P. pullata* | | 3.0 | 4.0 | 2.8 |
| *P. armentata* | | 1.5 | | |
| *P. nigriceps* | | | 2.0 | 2.8 |
| *Xerolycosa miniata* | | | 6.0 | 2.8 |
| *Alopecosa pulverulenta* | 8.6 | 1.5 | 4.0 | |
| *A. barbipes* | 1.1 | 3.0 | | |
| *Trochosa ruricola* | 1.1 | 14.8 | | |
| *T. terricola* | | 1.5 | 4.0 | |
| ***Arctosa perita*** | **105.2** | **118.4** | **103.4** | **41.8** |
| ***A. leopardus*** | | **54.8** | | |
| *Pirata piraticus* | 2.1 | 7.4 | | |
| **Pisauridae** | | | | |
| *Pisaura mirabilis* | | | | 5.6 |
| **Agelenidae** | | | | |
| *Agelena labyrinthica* | | 1.5 | | |
| **Dictynidae** | | | | |
| *Argenna subnigra* | 6.4 | 1.5 | 2.0 | |
| **Liocranidae** | | | | |
| *Agroeca proxima* | 1.1 | 5.9 | 4.0 | |
| *Agraecina striata* | | | | 5.6 |
| **Clubionidae** | | | | |
| *Cheirocanthium virescens* | | 1.5 | | |
| **Gnaphosidae** | | | | |
| *Drassodes cupreus* | | | 2.0 | |
| *Haplodrassus dalmatensis* | | | 4.0 | |
| ***Zelotes electus*** | | **3.0** | | |
| **Thomisidae** | | | | |
| *Xysticus cristatus* | | 1.5 | 6.0 | 5.6 |
| *X. kochi* | 1.1 | | | |
| **Salticidae** | | | | |
| *Euophrys frontalis* | | | 2.0 | 2.8 |
| **OPILIONES** | | | | |
| **Phalangiidae** | | | | |
| *Oligolophus tridens* | 6.4 | | | 2.8 |
| *Paroligolophus agrestis* | | 1.5 | | |
| ***Phalangium opilio*** | **51.5** | **325.6** | **214.8** | **198.0** |
| ***Opilio saxatilis*** | **1.1** | **8.9** | **53.7** | **55.8** |
| **Number of arachnids** | **409.0** | **1645.7** | **499.2** | **379.3** |
| **Number of species of arachnid** | **25.0** | **37.0** | **26.0** | **17.0** |

52 species of spider and 4 species of harvester were found. The linyphiids *Oedothorax fuscus*, *Oedothorax retusus, Erigone dentipalpis, Erigone atra,* and *Erigone longipalpis* were all found most commonly in the 'organic' slack apart from *Erigone longipalpis*. All these species are common and familiar aeronauts and therefore also turn up in fewer numbers on the dunes. The only other linyphid of interest is *Mecopisthes peusi* a species found in Wales exclusively on maritime dunes. It can be very common on the Newborough dunes but was also found in 2013 only in small numbers even on the dunes of the unexcavated slack - Slack 1 – (Loxton 2014). *Pachygnatha degeeri* can also be a very common species in the Newborough slacks but only a few were taken in 2014 mostly in the 'organic' part. Among the wolf spiders (Lycosidae), which as a group lend themselves to being caught by pitfalls, *Pardosa monticola* was found abundantly in all four pitfall sites but predominately in the 'organic' slack. *Arctosa perita,* as was also the case in Slacks 2 and 3 in 2013, was found in large numbers in the slack as well as on the dunes. *Arctosa arctosa* is a species with colour and pattern that suggests it is camouflaged on the sand as opposed to the darker *Arctosa leopardus*, a species of damp vegetated ground, which here was common but limited to the 'organic' slack. Apart from *Mecopisthes peusi* the only other sand dune spider that was seen was the gnaphosid *Zelotes electus* with just a few being caught in the 'organic' slack. This is a little surprising as in the more vegetated dunes, *Zelotes electus* is found much more frequently on the dunes rather than the slacks.

Table 5. Adjusted numbers of miscellaneous taxa taken in pitfall traps.

| | Mineral Slack | Organic Slack | Dune E/S | Dune W/N |
|---|---|---|---|---|
| **MILLIPEDES** | | | | |
| **Julidae** | | | | |
| ***Ommatoiulus sabulosus*** | **8.6** | **9.0** | **12.7** | **12.2** |
| ***Cylindroiulus latestriatus*** | **27.9** | **7.0** | **26.5** | **50.2** |
| *Julus scandinavius* | | | | 2.7 |
| *Tachypodiulus niger* | 1.1 | 1.0 | | |
| **CENTIPEDES** | | | | |
| **Henicopidae** | | | | |
| ***Lamyctes emarginatus*** | | **3.0** | | |
| **ISOPODA** | | | | |
| **Philosciidae** | | | | |
| ***Philoscia muscorum*** | **4.3** | **4.0** | **35.7** | **24.4** |
| **Armadillidiidae** | | | | |
| ***Armadillidium vulgare*** | | | **19.6** | **4.1** |
| **Porcellionidae** | | | | |
| ***Porcellio scaber*** | **14.0** | **17.9** | **148.8** | **35.3** |
| **ORTHOPTERA** | | | | |
| **Tetrigidae** | | | | |
| ***Tetrix undulata*** | **1.1** | **45.8** | **1.2** | |
| **Acrididae** | | | | |
| ***Myrmeliotettrix maculatus*** | | **7.0** | | |
| **Blatellidae** | | | | |
| *Ectobius panzeri* | 1.1 | | | |
| **Forficulidae** | | | | |
| *Forficula auricularia* | 1.1 | | 2.3 | 1.4 |

| | | | | |
|---|---|---|---|---|
| **HYMENOPTERA** | | | | |
| **Pompilidae** | | | | |
| *Evagetes crassicornis* | | 1.0 | | |
| **Crabronidae** | | | | |
| *Tachysphex nitidus* | | | 1.2 | |
| *Crossocerus wesmaeli* | | 1.0 | | |
| *Oxybelus uniglumis* | | | 1.2 | |
| **Apidae** | | | | |
| *Halictus rubicundus* | | | 4.6 | |

The large mobile millipede *Ommatoiulus sabulosus* was found across all habitats, perhaps more commonly on the dunes as is also the case with the smaller *Cylindroiulus latestriatus*. The only centipede found was *Lamyctes emarginatus* a species having only a single ocellus on each side of the head and in Britain is apparently entirely parthenogenetic, as only females have ever been found. Why there should be no other species present is unknown. The woodlice *Philoscia muscorum* and *Porcellio scaber* were found principally on the dunes and *Armadillidium vulgare* exclusively so. The Common Ground-hopper *Tetrix undulata* and the Mottled Grasshopper *Myrmelotettrix maculatus* were both almost entirely restricted to the 'organic' slack habitat, which is unsurprising as of the four habitats sampled this alone provided sufficient and suitable vegetation. It was noted that the ground-hoppers were of a dark colour – presumably this is related to the dark colour of the soil surface in the 'organic' slack.

## 5.2. Finger Searching in Slacks 2 & 3

The results of the finger searching in Table 6 above require some qualification. There is an inevitable element of subjectivity that arises in this sort of sampling, and although I attempted to spread my searching widely over each habitat searched there must be a suspicion that one unconsciously chooses where to sample. A much more rigorous approach is necessary – perhaps marking out a grid in the slacks and randomly choosing areas to search. I fear I did not have time to set this up – or the surveying equipment – and the present exercise will have to stand as a qualitative and rather subjective assessment of the invertebrates present. Drawing firm conclusions about differences between the three slacks is probably unwarranted. I have equalised the searching effort to correspond to the effort in Slack 2. In Slack 4, the searching was restricted to the 'mineral' part of the slack whereas in Slacks 2 & 3 half of each sampling period was spent in habitat similar to the 'mineral' habitat of Slack 4 and half in the wetter areas where there is some residual vegetation.

Table 6. Adjusted numbers of invertebrates found by finger searching in Slacks 2, 3 & 4.

| | Slack 2 Slack | Slack 3 Slack | Slack 2 Dune | Slack 4 Slack |
|---|---|---|---|---|
| Time, hours | 8.5 | 6.0 | 1.5 | 2.0 |
| **Coleoptera** | | | | |
| Notiophilus aquaticus | | 1.4 | | |
| **Elaphrus riparius** | **14.0** | **32.6** | | |
| Dyschirius globosus | | 4.3 | | |
| **D. politus** | **4.0** | **5.7** | | |

| | | | | |
|---|---|---|---|---|
| Trechus obtusus | | 1.4 | | |
| **Bembidion pallidipenne** | | **4.3** | | **12.8** |
| B. illigeri | | 1.4 | | |
| Poecilus versicolor | | 1.4 | | |
| **Agonum marginatum** | **3.0** | **11.3** | | |
| Amara similata | 1.0 | | | |
| Harpalus rubripes | | 1.4 | | |
| Helophorus brevipalpis | 4.0 | 4.3 | | |
| Georissus crenulatus | 1.0 | | | |
| Laccobius ytenensis | 1.0 | | | |
| Leiodes rufipennis | | | | 4.3 |
| **Bledius subniger** | **45.0** | **43.9** | | **144.5** |
| B. gallicus | 1.0 | | | |
| Carpelimus corticinus | | 1.4 | | |
| Hoplia philanthus | | | 5.7 | |
| **Dryops ernesti** | **3.0** | | | |
| **Heterocerus flexuosus** | | **1.4** | | |
| Agrypnus murinus | | | 5.7 | |
| Coccinella 11-punctata | | | | 4.3 |
| Isomira murina | | 1.4 | | |
| Phylotreta undulata | | | 5.7 | |
| **Protapion ononidis** | | | **85.0** | |
| **Philopedon plagiatus** | **1.0** | **4.3** | **79.3** | |
| **Otiorhynchus ovatus** | | | **5.7** | |
| **Charagmus griseus** | | | **5.7** | |
| **Heteroptera** | | | | |
| **Gamsocoris punctipes** | | | **62.3** | |
| **Macrotylus paykuli** | | | **45.3** | |
| **Cymus claviculus** | **3.0** | **1.4** | | **4.3** |
| Gerris thoracicus | 1.0 | | | |
| **Saldula saltatoria** | **22.0** | **19.8** | | |
| **Aculeates** | | | | |
| Cerceris arenaria | | | 11.3 | |
| **Lepidoptera** | | | | |
| **Argynnis aglaja** | | | **28.3** | |
| **Araneae** | | | | |
| Theridion impressum | 1.0 | | | |
| Oedothorax fuscus | 3.0 | | | |
| Erigone atra | 2.0 | | | |
| E. dentipalpis | 3.0 | 2.8 | | |
| **Arctosa perita** | **14.0** | **2.8** | | |

Some of the observations made from the finger searching will be amplified by the results of the next section concerned with *Bledius subniger* and we can also make reference to the results above of the pitfall trapping. For instance, the ground beetles *Elaphrus riparius* and *Agonum marginatum* were found frequently in Slacks 2 & 3. However they were found in the wetter parts of the slacks where there is some vegetation and infrequently on the open drier areas. They were not found by finger searching in Slack 4 but here only the mineral slack was searched and both species were numerous in the pitfalls in the 'organic' part of Slack 4. These two species are active runners and are easy to 'flush' from under plants such as Jointed Rush. No

*Dyschirius impunctipennis* were found in the finger searching though a few were found in pitfalls in Slacks 2 & 3 in 2013 and the species was found in large numbers in the pitfalls in Slack 4 in 2014 (see above). However *Dyschirius politus* was seen in both Slack 2 and 3 albeit in small numbers (Table 6) and this is a species characteristic of the embryo slack habitat. *Dyschirius politus* was present in substantial numbers in the pitfalls in Slack 4. *Bembidion pallidipenne*, another species of embryonic slacks, was seen in Slack 3 and Slack 4 when finger searching. This is a species that is 'flushed' when exploring the surface of the slacks – possibly in contrast to the *Dyschirius* species which are burrowers (see next section), and therefore are less obvious. *Bledius subniger* was found frequently in all three slacks by investigating its casts with a penknife and apparently most abundantly in Slack 4. However *Bledius subniger* was not found in the wetter areas of the slacks where half the sampling time in Slacks 2 & 3 was spent; in Slack 4 the finger sampling was restricted to the beetle's habitat in the 'mineral' slack.

As was remarked in Loxton (2014) there was a paucity of *Dryops* and *Heterocerus* beetles in the pitfalls in the excavated slacks and this was again the case in 2014 with the finger searching. This suggests that these beetles are in fact scarce in the excavated slacks, and the slack habitat has perhaps not yet progressed in succession sufficiently for these species. The bug *Saldula saltatoria* was common in the wetter, more vegetated parts of Slacks 2 & 3 but not as common as I expected. Again it is possible that the vegetation has not yet matured enough. Again as in the pitfall trapping, the Wolf Spider *Arctosa perita* was found commonly in the slacks but interestingly was not found on the excavated dunes. This species makes a burrow in loose sand so was probably overlooked whereas in the slacks it is flushed. It was certainly present in pitfalls on the excavated dunes in 2013 (Loxton, 2014).

I visited the excavated dune habitat in fine sunny weather when the surface of the bare sand was almost devoid of invertebrate life apart from the weevil *Philopedon plagiatus*. Even this creature was finding life difficult by being trapped in hoof prints in loose sand from which it could not escape, and dying in considerable numbers. On the few times I visited this habitat at night, there was even less to find on the surface of the sand apart from the occasional millipede. Most of the insects I found were revealed by shaking the scattered vegetation where more *Philopedon plagiatus* were found with a few *Charagmus griseus* and *Otiorhynchus ovatus.* The weevil *Protapion ononidis* and the bugs *Gampsocoris punctipes* and *Macrotylus paykuli* were found under their host plant, Restharrow. The presence of several Dark Green Fritillaries may have been a consequence of the luxuriant growth of Dune Pansy on the excavated dunes. Individual plants of the Pansy grew on the bare sand to clumps six inches across with many flowers.

### 5.3. Observations of *Bledius subniger*

I initially found this species difficult to identify. I concluded that only one species was involved but was uncertain whether it was *Bledius subniger* or *Bledius fergussoni*. Fortunately I was able to send a long series to Dr Jervis Good who has made a speciality of studying coastal rove beetles and he was quite certain my material was *Bledius subniger.* I think this species is of interest in the context of the embryo slack habitat created by the excavations as it seems to be the principal colonist so far of those species specialised to this habitat and has brought with it as predators *Dyschirius politus*, *Dyschirius impunctipennis* and possibly *Bembidion pallidipenne*

(but see below).When starting this work in late April 2014, I was immediately struck by large numbers of small casts (Photo 7) on the surface of the excavated slacks, which it soon became apparent were those of *Bledius subniger* (Photos 8 & 9). I may have overlooked these in 2013 but they must have been present, as a few were taken in the pitfalls that year, but it seems likely there was a considerable increase in numbers between 2013 and 2014. In the course of finger sampling in Slacks 2 & 3 and pitfall trapping in Slack 4 it was obvious that there were many *Dyschirius* beetles being caught in the pitfalls but I was finding few by finger searching and vice versa with respect to *Bledius subniger.* Table 7 shows the results of a simple comparison of the captures.

Table 7. Numbers of captures by pitfall trapping compared with those taken by finger searching for *Dyschirius impunctipennis, Dyschirius politus, Bembidion pallidipenne* and *Bledius subniger* in Slack 4.

| Caught in 5 pitfalls between 21-29 July 2014 | | Taken by finger searching for one hour on 24 and again on 26 July 2014 | |
|---|---|---|---|
| *Dyschirius impunctipennis* | 25 | *Dyschirius impunctipennis* | 0 |
| *D. politus* | 3 | *D. politus* | 0 |
| *Bembidion pallidipenne* | 18 | *Bembidion pallidipenne* | 3 |
| *Bledius subniger* | 4 | *Bledius subniger* | 34 |

It is clear that the proportion of prey (*Bledius subniger*) to predators (*Dyschirius* and *Bembidion*) depends upon the sampling method. *Dyschirius* beetles are usually reported as associated with *Bledius* on which they are presumed to prey. At least one species, the smallest, *Dyschirius globosus*, is not associated with *Bledius*. It can be seen that *Dyschirius politus* (Photo 10) is well adapted to burrowing with a narrow 'waist' between thorax and abdomen allowing flexure about this joint, a cylindrical body shape and powerful front limbs with stout, spiny tibiae. I have included *Bembidion pallidipenne* in this section because it is a familiar species of this habitat, and from its known distribution apparently specialised to this habitat, but its body shape (Photo 11) is quite different from *Dyschirius* being dorso-ventrally flattened, un-waisted and with much less robust forelimbs. As remarked above it is often flushed when finger searching the slack surface and if it is a predator of *Bledius* it is likely to be taking them on the surface and not by burrowing after them. There are other prey items on the surface of the damp sand including at least two species of Collembola and several bugs including *Saldula* and *Cymus,* and no doubt other small creatures such as nematodes, small enchytraeid worms and mites. However, if the *Dyschirius* are dependant on the *Bledius* it cannot be that the predator outnumbers its prey. One must assume that the relative numbers taken are biased by the two sampling methods. Finger searching the *Bledius* casts does sometimes turn up *Dyschirius* (see below) but not in this small exercise where the *Dyschirius* beetles are abundant in the pitfalls (Tables 2 & 7). Presumably the *Bledius* spend most of their time underground but the predators explore the surface in search of the burrows and make themselves available to be caught in pitfalls.

Another question we might ask, if the *Bledius* are so numerous, is on what are they feeding? Table 8 shows the mean loss in weight after ignition (this can be taken as a close approximation of the percentage organic content) and the pH, as measured by Dr Jones from samples I supplied from areas in the three slacks where *Bledius* were abundant. It is clear that as might be expected from looking at the sand that the

organic content was very low – the pH is well on the alkaline side of neutral, presumably from the shell content of the sand. One can only speculate that there is a microscopic flora and/or fauna interstitially, or on the surface of the sand particles, on which the *Bledius* are feeding. This is clearly a specialised way to obtain food and no doubt it would be of interest to microscopically examine the sand and the gut contents of the beetles and also the mouthparts of the insects – both larvae and adults.

Table 8. Mean % loss of weight after ignition, and ph of five samples from Slacks 2, 3 & 4.

| | Slack 2 | Slack 3 | Slack 4 |
|---|---|---|---|
| Mean % loss of weight | 0.56 | 0.25 | 0.27 |
| 95% Confidence limits of mean | ±0.1 | ±0.04 | ±0.05 |
| | | | |
| Mean pH | 8.22 | 8.41 | 8.53 |
| 95% Confidence limits of mean | ±0.2 | ±0.08 | ±0.07 |

The map shown in Figure 1 was drawn on the 16th and 19th June and indicates that the *Bledius* at this time were restricted to only parts of Slack 2. Much of this slack was still shallowly flooded or waterlogged, the light blue areas in Figure 1. There were other parts that the excavation had left more elevated above the water table that were dry by this time with the sand friable and capable of being blown by the wind (brick red areas in Figure 1). The *Bledius* were found in the areas in between these extremes.

As the season advanced and the water table dropped the *Bledius* casts appeared further into the slack, as it dried out from the winter flooding. I did a little sampling with the bulb planter on 19th September at the six positions shown by the numbers in Figure 1. At each position, I took 10 samples by dropping the bulb planter over my shoulder. The number of beetles found at each site is shown below in Table 9.

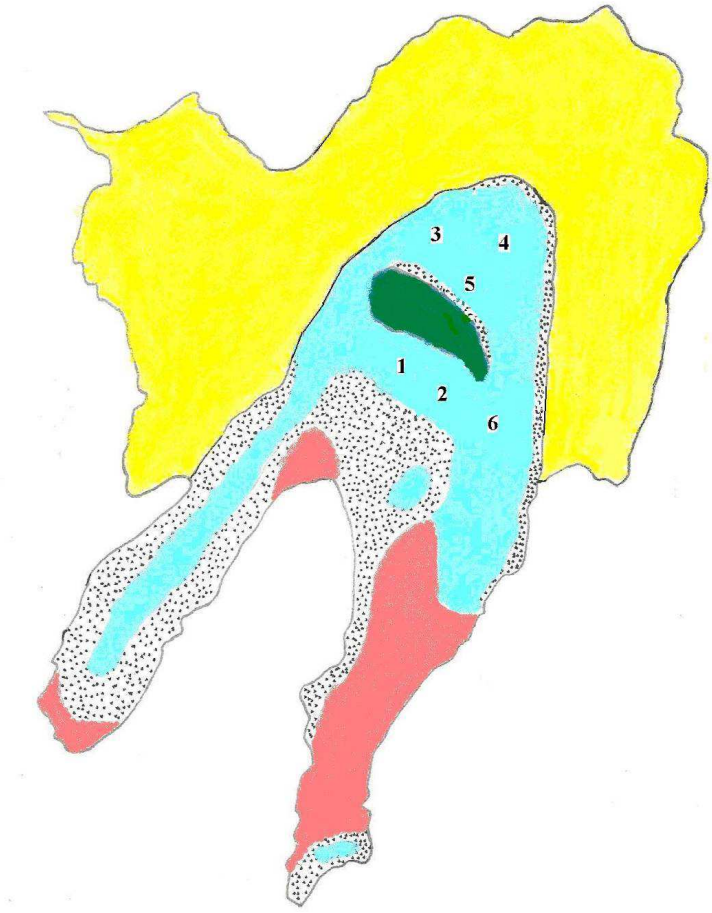


Figure 1: Sketch map of the excavated area of Slack 2 drawn on 16th June, showing the approximate areas of the slack where Bledius casts were found (black stippled areas), and indicates the area of excavated dune habitat (yellow), dry sand areas in the slack (brick red), waterlogged or flooded areas (pale blue) and the 'island' of unexcavated slack (dark green). The numerals 1-6 indicate where core samples were taken on 19th September.

Table 9. Number of beetles at six core sampling sites on 19th September 2014.

| | *Bledius subniger* | *Dryops* | *Helophorus* |
|---|---|---|---|
| Site 1 | 3 | | |
| Site 2 | 5 | | |
| Site 3 | 1 | 1 | 1 |
| Site 4 | | | |
| Site 5 | | | |
| Site 6 | 4 | | |

In June when the initial survey was done, the slack still had areas with some flood water or the sand was waterlogged. By September, no open water remained but some of the slack at the north end still had sand that was very damp and coated with a bubbly, brown slime – in the area of Site 3. This bubbly appearance was at first taken by me to indicate the burrows of an invertebrate. However lengthy searching

revealed nothing and I came to the conclusion that these 'bubbles' were probably caused by gas generated in the rotting organic material in this part of the slack that remains damp if not flooded most of the year. The six sites are shown in Photos 12-17. The position at the approximate centre of the sampling is indicated by an upturned plastic funnel in the centre of each photo. Two points emerge from the data in Table 9: firstly the *Bledius subniger* were found on 19th September in areas that were apparently unsuitable in June (Figure 1) when there was much more water in the slack and secondly Sites 3, 4 & 5 apparently held few *Bledius.* These sites were all flooded for much of June and July and had acquired a coating of dried out fibrous *Zygnema* alga. Photo 18 shows this alga on the surface shortly after open water on the surface had evaporated, though the sand was still waterlogged as can be seen by the deep hoof prints of the ponies. Where a thick layer of this alga was deposited on drying out, my impression was that the thick fibrous mat made the sand surface inhospitable to *Bledius*. The increase in the organic content of the sand in the excavated slacks will no doubt be contributed to by this algal mat. Other sources of organic material will be the higher plants in the wetter areas, pony dung and to a small extent the nitrogen brought in by the gulls that roost in these slacks in May and June providing nutrients for the plants.

Another observation concerned the possibly detrimental effect the ponies have with respect to the embryonic slack fauna. If one probes the intact slack surface in areas with *Bledius* casts the surface comes away in a thin (about 5mm) layer of weak crust. Even late in the summer the sand is damp under this crust. However if the crust has been broken, the sand dries out and becomes mobile, quite unsuitable for burrowing by the *Bledius* and presumably too dry to support the microflora and fauna on which the beetles may be presumed to feed. The maintenance of this crust is probably essential for the habitat to support its specialised fauna. As Slack 2 dried out, some areas were deserted by the *Bledius* such as the thin strip of casts on the northern edge of the 'island and along the north-eastern edge of the slack and the edges in the other parts. This was also noted in Slack 4 where the edge of the 'organic' area had a thin band of *Bledius subniger* containing habitat that by late summer had been apparently deserted by the *Bledius*. It is interesting to note from the pitfall trapping in Slack 4 that *Bledius gallicus* was found only in the 'organic' slack and *Bledius subniger* predominantly in the 'mineral' slack. I failed to find any casts of burrowing in the 'organic' area and possibly *Bledius gallicus* lives in a different manner to *Bledius subniger*. Lott (2009) gives the habitat of *Bledius gallicus* as 'in sand by streams and rivers, sandpits, small patches of bare ground in marshes'.

As to the life cycle of *Bledius subniger,* I only have some indirect information. Adults appear at least by late April. One can find larvae in the areas where casts were found but I have not had the time to study these at all. Also occasionally I have found larvae of presumed *Dyschirius* in the sand. As the data presented above indicate, adults were present in the slack at least into mid September. I found a few teneral adults in the pitfalls in Slack 4 in the dune habitat in September. It seems unlikely that the beetles could survive months under water over the winter and one must presume that the adults leave the breeding habitat in autumn, and winter elsewhere. We could speculate that the species has a long summer breeding season possibly with more than one generation, migrates away from the slack in the autumn and over-winters as an adult. Embryonic slack is by its nature a patchy and ephemeral habitat and the *Bledius* is probably well adapted to colonise such habitat as it becomes available,

and to breed rapidly. Certainly the speed with which this species, and its predators, have colonised these excavated slacks and their abundance in 2014 suggests support for the previous sentence.

### 5.4. Pioneer dune slack beetle species

Of the 16 species of beetle regarded as being associated with pioneer dune slacks on Newborough Warren, six were recorded in 2014 (Table 10). Five of the six species found in 2013 were re-found in 2014, with the addition of *Heterocerus flexuosus* from Slack 3. With only *Dryops nitidulus* and *Gabrius osseticus* recorded from the control Slack 1, in 2013, it suggests that these species are colonising the excavated slacks from remnant pockets of suitable habitat within the dune system rather than records representing a legacy of existing populations within the slacks, although it is possible that the edges of old ponds used by livestock provided refuges. It will be interesting to see if the slack are colonised by the remaining species over time, particularly those for which there are no recent records from the dune system.

Table 10. Pioneer dune slack beetle species recorded from Newborough Warren.

| Species | 2013 | 2014 | Slack 1 (control) | Slack 2 | Slack 3 | Slack 4 | Date last recorded |
|---|---|---|---|---|---|---|---|
| *Dyschirius politus* | x | x | | x | x | x | 2014 |
| *Dyschirius salinus* | | | | | | | 2003 |
| *Dyschirius thoracicus* | | | | | | | 2011 |
| *Asaphidion pallipes* | | | | | | | 1981 |
| *Bembidion pallidipenne* | x | x | | x | x | x | 2014 |
| *Bembidion clarki* | | | | | | | 1985 |
| *Bledius fergussoni* | | | | | | | 1964 |
| *Bledius fuscipes* | | | | | | | 2011 |
| *Bledius longulus* | | | | | x | | 2013 |
| *Bledius opacus* | | | | | | | 2010 |
| *Bledius subniger* | x | x | | x | x | x | 2014 |
| *Thinobius brevipennis* | | | | | | | 1982 |
| *Gabrius osseticus* | x | x | x | | | x | 2014 |
| *Heterocerus flexuosus* | | x | | | x | x | 2014 |
| *Dryops nitidulus* | x | x | x | | | x | 2014 |
| *Dryops striatellus* | | | | | | | 2011 |

## 6. Discussion

Since the monitoring carried out in 2013 there seems to have been little change in the fauna of the excavated slacks except for a great increase in the numbers of *Bledius subniger* and the ground beetles *Dyschirius politus, Dyschirius impunctipennis* and *Bembidion pallidipenne.* There appears to have been no similar increase of the species of *Dryops* and *Heterocerus* that are associated with embryonic slack habitat, although *Heterocerus flexuosus* was recorded in Slack 3. The increase in abundance must either be breeding in 2013 or continued immigration from elsewhere. I am inclined towards the first possibility. The pitfall trapping in Slack 4 revealed that, as in Slacks 2 & 3 in 2013, *Gabrius osseticus* was common in the

pitfalls. At this point it is only possible to speculate that the excavated slack surfaces are not yet suitable for the colonisation by these other species. It is possible that the excavation has lowered the slack surface so that it stays wetter than an undisturbed slack. It would perhaps be useful to monitor the top few centimetres of the soil in these slacks, comparing excavated with unexcavated slacks and with natural embryonic slacks at Morfa Dyffryn and Morfa Harlech. It seems likely that soil moisture and plant cover are going to be important features of the habitat for the invertebrates. Such a study can be carried out if a suitable soil probe can be obtained; this is being currently pursued. It would then be possible to study the soil moisture in the surface layer over a season and relate this to the distribution of *Bledius subniger* and other species. *Bledius subniger* lends itself to relatively easy mapping of its distribution from its casts.

In various reports concerning pitfall trapping it has been emphasised how biased this technique can be when comparing the abundance of different species. This was strikingly borne out by the comparison of finger searching with pitfall trapping in the numbers of *Bledius subniger* that were caught as opposed to its predators. If one considered the pitfall trapping alone *Bledius subniger* would be considered uncommon but its presence was seen to be widespread and abundant from finger searching and recording the casts. However the finger searcher inevitably investigates casts and this again biases the results. The low numbers of the *Dyschirius* found by finger searching is in marked contrast to the large numbers taken in the pitfalls. To get a more accurate measurement of the numbers of these species the core sampling will give much clearer results. However it requires a supply of water on the ground and time. If carried out intensively the technique might be destructive. Unfortunately it only became apparent to me rather late in the summer that there was this problem and the results of the core sampling come from work late in the summer when perhaps the abundance of these species is declining – the results above are of a preliminary nature. As work in 2015 has already been planned, it is unlikely that I will be able to follow up some of these concerns. It seems to the writer that there is an interesting study of this fauna to be carried out that would merit the full time attention of a research student. The different ecologies of *Bledius subnige*r and *Bledius gallicus* are also worth considering.

It seems from these observations that the intention of the intervention has succeeded in successfully establishing in part a vigorous population of the embryonic slack fauna, with sevenspecialist beetle species recorded from Slacks 2 to 4 over the last two years. We do not know the relationship of the other species such as the species of *Dryops* and *Heterocerus* to the age of the embryonic slack. Are the *Bledius* and *Dyschirius* discussed here restricted to newly exposed sand near to the water table as one would find around the parabolic edge of an actively progressing slack? It seems possible that it is this habitat that has been artificially created by the excavations and produced an enlarged area of the habitat that would naturally constitute a thin strip behind the retreating slack face. Behind this area, where there is more vegetation in natural embryonic slacks, may be the habitat preferred by others species that have been collectively lumped with the *Bledius* and *Dyschirius* as embryonic slack fauna. Perhaps the pitfall trapping planned in 2015 at Morfa Dyffryn may find an answer to this.

If the slack habitat has been enhanced by excavation towards embryonic slack there is as yet no evidence that the bare sand exposed on the dune habitat has attracted species such as *Broscus cephalotes* and *Xanthomus pallidus* that at present appear to be limited to the dunes immediately behind the beaches. However no pitfall trapping was carried out on the dunes in 2014 and little was found by finger searching. Some boards were put out but nothing was found. Whether these species, which were present further inland 30 years ago, are less mobile than the embryonic slack fauna discussed above is unknown. Possibly a corridor of bare sand habitat out to the shore is needed. Pitfall trapping on the bare sand is unproductive and frustrating due to blown sand and disturbance by ponies and will not be possible to carry out by myself until 2016.

## 7. Recommendations

The botanical monitoring of the plots marked out in the slacks should be continued in liaison with Dr Laurence Jones of CEH. Some monitoring of the invertebrates should continue and some fencing off of the excavated slacks should be considered to protect at least some of the exposed surface from being broken up by the ponies.

## 8. Acknowledgements

I am grateful to Dr Tristan Bantock for identifying some Hemiptera and commenting on distribution, to John Bratton for identifying *Laccobius ytenensis*, to Carl Clee for help with aculeates, to Dr Jervis Good for identifying *Bledius subniger*, to Dr Laurence Jones for analysing the soil samples and a photograph of *B. subniger,* to Dr Geraldine Reid for identifying the alga *Zygnema,* to Dr Alan Stewart for comments on the distribution of Auchenorrhyncha, and to Tony Hunter and Philip Rispin for support at Liverpool and Manchester Museums respectively.

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# 10. Appendices

## 10.1. Appendix A: Photographic images


Photo 1. Aerial photographs of the excavated slacks. Slack 4 is in the middle of the lower half of the photograph. The dune sampled can be seen on the south west corner of the excavated area as a bulge into the vegetated areas. In the slack itself what I have referred to as 'mineral slack habitat' can be seen in the northern part of the slack as a an area of pale coloured sand. What I have called the 'organic slack habitat' can be seen as the darker are to the south. It is also possible to see in Slacks 2 & 3 areas where the slacks are wettest (towards the north-east) showing as green areas and the drier areas showing up as paler areas.

Photo 2. The north western dune ridge of Slack 4 with a dense growth of Creeping Thistle, some large Ragwort plants and Rosebay Willowherb, 26th July 2014. The dune pitfalls were placed on the flanks of this ridge.

Photo 3. The south eastern slope of the dune ridge
where pitfalls were placed. Some of the 'mineral' slack can be seen in right background.

Photo 4. ‘Mineral’ part of Slack 4, 23rd May 2014. The slack was still damp here after winter flooding and the dark surface contrasts with the dry yellow sand at the edge of the slack in the background.

Photo 5. ‘Organic’ slack, 23rd May 2014. Note the dark surface of the soil.

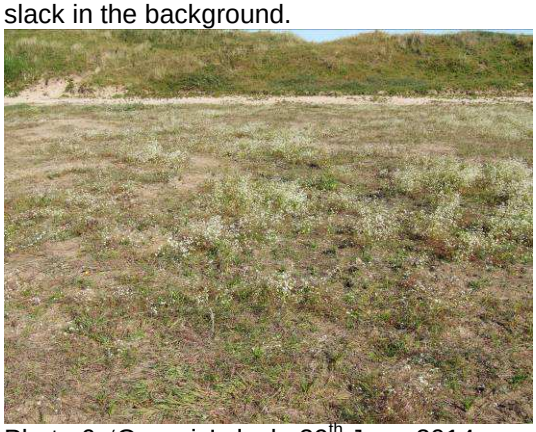

Photo 6. ‘Organic’ slack, 29th June 2014. Note the dense growth of Common Marsh Bedstraw in middle ground.

Photo 7. Cast of *Bledius subniger* burrow in centre of picture. Photo by Dr Jones, 1st July 2014.

Photo 8. *Bledius subniger* exposed in its burrow. Photo by Dr Jones 1st July.

Photo 9. *Bledius subniger*. This species is only 3mm long.

Photo 10. *Dyschirius politus.* 4-4.5mm.

Photo 11. *Bembidion pallidipenne*. 4.3-4.9mm.

Photo 12. Site 1 (see Figure 1) in Slack 2, 19th September. The surface has a light crust of dried alga.

Photo 13. Site 2, drier than Site 1 with little algal crust.

Photo 14. Site 3, wet area with a brown bubbly crust.

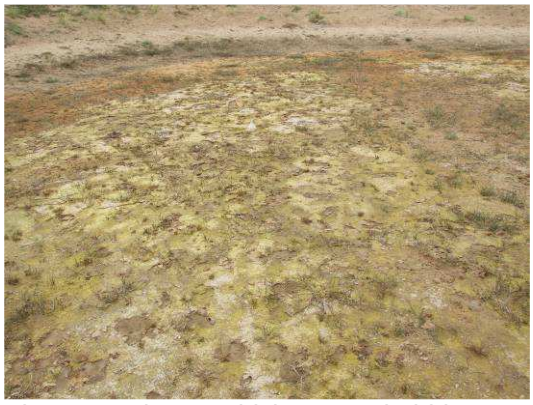

Photo 15, Site 4, a thick, green, bubbly crust formed of a fibrous alga. This dries out to a white mat.

Photo 16. Site 5, a dry area with little crust and with some organic debris in the samples.

Photo 17. Site 6, A dry area with small bits of organic material in the samples.

Photo 18. Slack 2, 16th June. Fibrous alga (*Zygnema* sp) coating the wet surface of the slack to the east of Site 5. Note heavy disturbance of surface by ponies.

Photo 19. *Cotoneaster simonsii*, 20th June. Plant was in flower and setting seed.

Photo 20. *Cotoneaster franchettii*

Photo 21. *Clematis vitalba*, 7th July. The bright green foliage makes this species stand out on the dunes.

Photo 22. *Aquilegia vulgaris*, 26th May. On dunes between Slacks 3 & 4.

Photo 23. *Aster ?lanceolatus*, 24th October between Slacks 3 & 4.

## 10.2. Appendix B: Heteroptera and Auchenorrhyncha taken in Slacks 1, 2 & 3 in 2013.

| | Mean bugs/site Slack 1 dunes | Mean bugs/site Slack 1 slack | Mean bugs/site Slacks 2&3 dunes | Mean bugs/site Slacks 2&3 slacks |
|---|---|---|---|---|
| **Heteroptera** | | | | |
| *Saldula saltatoria* | | 53.7 | | 12.6 |
| *Acalypta parvula* | 2.1 | | | 0.2 |
| *Dictyonota strichnocera* | 0.4 | | | |
| *Mecomma dispar* | | 0.3 | | |
| *Himacerus mirmicoides* | 0.7 | | | |
| *Nabis pseudoferus* | | | 0.1 | 0.4 |
| *Nysius thymi* | | | 0.2 | |
| *Drymus pilicornis* | | | 0.1 | |
| *Trapezonotus arenarius* | 6.7 | | 0.2 | 0.2 |
| *Megalonotus chiragra* | 0.7 | | 0.0 | |
| *Peritrechus geniculatus* | | | 0.2 | |
| *Stygnocoris sabulosus* | 2.8 | | | |
| *Berytinus signoreti* | 0.3 | | 0.1 | |
| *Gampsocoris punctipes* | 1.8 | | 0.1 | |
| *Chlamydatus ?saltitans* | | | | 0.6 |
| **Auchenorrhyncha** | | | | |
| *Philaenus spumarius* | 2.4 | | | |
| *Megophthalmus scabripennis* | 4.2 | 0.7 | | 0.4 |
| *M. scannicus* | | 0.7 | | |
| *Evacanthus interuptus* | 1.4 | | | |
| *Macropsis impura* | | 0.3 | | |
| *Anaceratagallia frisia* | 6.6 | | 2.4 | 0.4 |
| *A. laevis* | 0.4 | 0.3 | | |
| *Eupelix cuspidata* | 1.4 | 1.0 | | |
| *Aphrodes bicincta* | 3.2 | 0.7 | | 0.2 |
| *Anascopus albifrons* | 3.1 | 0.3 | | |
| *A. histrionicus* | | 0.3 | | |
| *Doratura stylata* | | 0.3 | | |
| *Acrocephalus punctum* | 2.8 | | 0.3 | |
| *Verdanus abdominalis* | | | | 0.2 |
| *Mocydiopsis attenuata* | 1.7 | | | 0.2 |
| *Macrosteles ?sexnotatus*♀ | | | | 0.2 |
| *Eupteryx notata* | 1.7 | 0.3 | | |
| *Delphacinus mesomelas* | | 0.3 | | |
| *Criomorphus albomarginatus* | | | | |
| Number of species | 19.0 | 13.0 | 9.0 | 11.0 |
| Mean no. of individual bugs. | 44.6 | 62.0 | 3.7 | 14.3 |

The material collected in these taxa were not identified in time to include in my previous report. All these bugs were collected in pitfalls in the three slacks studied in 2013. The results were similar to the other taxa recorded in 2013 with a reduction of species and numbers of bugs in the excavated slacks and dunes of Slacks 2 &3 compared with Slack 1 which was unexcavated and acted as a control. In only two species, *Saldula saltatoria* and *Anaceratogallia frisia* were more than one or two individuals caught.

## 10.3. Appendix C: Records of species taken in 2014 and not known to have been previously recorded at Newborough Warren NNR or Newborough Forest, or with very few previous records from the dune system.

I have included here some species that were taken in Newborough Forest in an old slack near the edge of the forest bordering the Cefni Estuary (SH396656) where I carried out a pitfall survey in 2014 – this work is recorded in a separate report. This old slack in the forest has been given the name Pant Heli for ease of communication.

**Heteroptera**

*Megalonotus dilatatus* (Herrich-Schäffer, 1840). Although there are records from a wide area of Britain, this ground bug is largely confined to the south. It is generally found amongst litter in dry places (Recorder, 2000). 33 individuals were taken on the dunes of Pant Heli.

*Berytinus signoreti* (Fieber, 1859). Two individuals were taken in 2013 in pitfalls in Slack 1 and Slack 3. A further individual was taken in 2014 in Slack 4. A widely distributed but somewhat local stilt bug, often associated with white clover, usually in dry places: found in a wide range of habitats (Recorder, 2000). Previously recorded on Newborough Warren by Roy Crossley in 1972.

**Auchenorhyncha**

*Anaceratagallia frisia* (Wagner, 1939). This species was found in large numbers in Slack 4 and at Pant Heli. This species according to Dr Tristan Bantock (pers.com.) was first recognised in Britain in South Wales but has since been found at Morfa Harlech, Morfa Dyffryn, and in Devon. Only the closely related *A. laevis* was recognised by Le Quesne (1965) but where *A. frisia* has been found, it is apparently much more numerous than *A. laevis,* and seems to be the dominant species on western sand dunes. Among the large numbers of *A. frisia* I took a few *A. laevis* in 2014 at both Pant Heli and Slack 4.

*Psammotettix nodosus* (Ribaut, 1925). This species was common in pitfalls in Slack 4 and Pant Heli. Biedermann and Niedringhaus (2009) give the habitat as sunny ± dry grasslands; on grasses. Dr Bantock informs me that he has found this species rarely – twice from dry grassland and once from shingle (Dungeness). There is a record from Tywyn Aberffraw dating from 1985 (W.J. Le Quesne).

*Streptanus aemulans* (Kirschbaum, 1868). A single female specimen of this common species was taken in a pan trap on the dune habitat in Pant Heli. Dr Bantock kindly identified this specimen. There is a 1953 record from Tywyn Aberffraw (P. Whalley).

*Macrosteles quadripunctulatus* (KBM, 1868). A single male was taken in the organic part of Slack 4. This is a nationally scarce species and according to Dr Alan Stewart (pers. comm.) it is almost certainly a new record for Wales. Alan goes on to say that existing records (a total of 15 10km squares) are mostly focused on East Anglia, SE and central England, with one isolated record from Braunton Burrows in Devon. Dr Bantock (pers. com.) has taken it on PFA at Tilbury Power Station. He commented that it likes very early succession habitats and is very scarce. I sent a photo of the Newborough habitat to Dr Stewart and he commented, ‘your description of the

habitat, and the photos, fits well with what little we know about its requirements, which seem to be dry and generally very open sparsely vegetated sites.

**Coleoptera**

*Leiodes longipes* (Schmidt, W.L.E., 1841). A single male was taken in the 'organic' part of Slack 4. This is a rare species given the status of RDB I by Recorder 2000 – NBN holds only nine records. Recorder speculates that although nothing is known of its specific ecology it may be associated with underground fungi on sandy substrates. The British authority on the genus, Jon Cooter, observed that he was 'unaware of any captures since the 1960s, (Culgaith, Cumberland)' (Cooter, 1996). The males are distinctive in colouring, aedeagus and the hind legs. There is a small series in the Manchester Museum with which I was able to compare the Newborough specimen. Dr Howe has no previous Welsh records of this beetle.

*Choleva angustata* (Fab., 1781). Several males were taken in pitfalls in Pant Heli - a common species that may have been overlooked at Newborough in the past. NBN records very few Welsh records.

*Carpelimus rivularis* (Motschulsky, 1860). A single female of this common species was taken in the 'organic' part of Slack 4. Lott (2009) gives the species' habitat as 'found in a variety of wetland and riparian environments with silty substrates'.

*Stenus comma* LeConte, 1863. A single male of this local species was taken in a pitfall in the organic part of Slack 4. The habitat is given by Lott and Anderson (2011) as 'mostly riparian on sandy loams and gravel deposits'. NBN shows no previous records for Anglesey.

*Quedius schatzmayri* Gridelli, 1922. Several taken in Slack 4 and Pant Heli. A common species found in a variety of environments on damp soils, according to Lott and Anderson (2011). It was previously recorded on Newborough Warren by Oliver Gilbert between 1950 and 1952.

*Apion rubiginosum* Grill, 1893. A single individual taken in a pitfall trap on one of the dunes in Pant Heli. Recorder 2000 gives this species a status of provisionally RDB3 but it is probably better considered as Local. Morris (1990) describes it as occurring in sandy places on *Rumex acetosella* agg. – very local and not generally common, but widely distributed through England and Wales. NBN shows no previous records for Anglesey.

*Scolytus rugulosus* Müller, P.W.J., 1818. A single individual taken in Pant Heli. This small bark beetle is found on *Pyrus*, *Prunus*, *Rosa* etc, (Duffy 1953). Recorder 2000 has it living under the bark of old fruit trees. There are several mature Hawthorn, Cherry and Apple trees in the vicinity. NBN shows no previous records for Anglesey.

**Aculeate Hymenoptera**
*Halictus rubicundus* (Christ, 1791). Several females were taken in pitfalls on the dunes of Slack 4. It is perhaps surprising that this common species has not previously been recorded at Newborough – there are several records for Anglesey.

**Araneae**
*Agraecina striata* (Kulczyński, 1882) – Three males were taken in pitfalls in Pant Heli and two in Slack 4 on the dunes. A nationally scarce species and according to Richard Gallon (pers. com.) a new record for North Wales. According to Recorder 2000 it is found on wet heath, bogs, marshes and fens, and most records are from south of a line from the Wash to Cardigan Bay, though there is one record from Kirkcudbrightshire. However Harvey et al (2002) add that it is found in a range of coastal habitats including wet grassland and dyke edges but also on dune and shingle.

*Drapetisca socialis* (Sundervall, 1883). A male was taken in a pitfall in Pant Heli. This common species is usually found well-camouflaged on the bark of tree trunks but is often taken on the ground (Harvey *et al*., 2002).

It seems worth mentioning here the ground beetle *Bembidion saxatile*, which has not been recorded at Newborough since O. Gilbert's record in 1950-52 (Gilbert, 1958). Eleven beetles were taken in pitfalls in the mineral and organic slack habitats of Slack 4 in 2014. Luff (2007) gives the habitat of this Local species as on sand or gravel near water, especially on the coast. In fact Gilbert's paper includes undifferentiated records from the estuaries of the Braint, Cefni and Ffraw, from Coed Llewelyn on the Bodorgan estate and the Aberffraw Dunes as well as Newborough, so his *B. saxatile* record may not be from Newborough Warren.

The true bug *Chlamydatus saltitans* also merits a mention. I took some specimens in 2013 of a bug I could not identify and referred them to Dr Bantock. He comments – 'this appears to be a macropterous example of *Chlamydatus saltitans*, but you need to check this with a good reference collection. This species has only ever been found as partly-winged in Britain'.

## 10.4. Appendix D: Notes on invasive species of plants.

Over the years that I have been working at Newborough I have recorded the sites of what are considered invasive species of plants that are considered potentially damaging to the dune habitat. One species, Gorse, is possibly not in this category but it is beginning to produce patches in the mid dunes and near the forest. I have only recorded Gorse here in the more seaward dunes. As I have mentioned in a previous report Blackthorn is producing large patches by suckering and is possibly a species that might be considered for control. To what extent other scrub should be removed is a matter for debate but I think the species listed below should be eradicated. Some of the plants and their locations have been recorded by me in previous reports but I thought it worth while bringing all these together with some new records for 2014.

| **On the dunes behind Traeth Penrhos, and the dunes and marsh of the Cefni Estuary** | |
|---|---|
| ***Clematis vitalba*** | |
| 38694 64755 | patch on dunes, |
| 38689 64734 | patch on dunes, possibly some outliers |
| 38819 65675 | patch on Cefni dunes |
| ***Rosa rugosa*** | |
| 38659 65320 | on dunes, patch |
| 38634 65207 | on dunes, patch of plants to 1m high |
| 38642 65085 | on dunes, patch of plants to 1m high |
| 38640 65059 | on dunes, small patch of plants with outliers, to 1m high |
| 38759 64573 | on dunes, small patch of plants with outliers, to 1m high |
| 38765 64559 | on dunes, patch of plants with outliers, to 1m high |
| 38791 64470 | on dunes, patch of plants with outliers, to 1m high |
| ***Hippophae rhamnoides*** | |
| 38660 65206 | on dunes. 20m patch, vigorous, 1-2 m high. |
| 38704 64767 | on dunes, 20m strip, to 1m high |
| 38845 64450 | single plant in valley |
| 38918 65645 | single plant on Cefni Dunes |
| 38912 65754 | patch on Cefni Dunes |
| 38882 65697 | patch on Cefni Dunes |
| 38740 65368 | single plant on Cefni Dunes |
| 39325 65867 | Patch |
| | |
| **Forest** | |
| ***Clematis vitalba*** | |
| 3917-6366- | at edge of forest |
| ***Rosa rugosa*** | |
| 400-- 658-- | a patch in the marsh at edge of forest |
| ***Hippophae rhamnoides*** | |
| 4032-6348- | Patch |
| 3989-6411- | small patch |
| 4072-6364- | patch, previously sprayed but re-growing. |
| | |
| **On the Warren** | |
| ***Clematis vitalba*** | |

| | |
|---|---|
| 42201 63633 | Behind Slack 2 |
| 41379 63656 | North of gate near forest |
| 41993 63196 | Mouth of Slack 2 |
| | |
| ***Cotoneaster franchetti*** | |
| 41540 63504 | Removed |
| 41540 63633 | Removed |
| ***C. simonsii*** | |
| 41447 63724 | Removed |
| 41099 63112 | beyond pony fence, not yet removed |
| ***Ulex europaeus*** | |
| 42449 63774 | spreading - smaller outliers. |
| 42107 63972 | spread since 2008 |
| 41767 63898 | big patch on damp ground of old grazing plots near forest. |
| 42032 63314 | Slack 2 |
| 42253 62990 | |
| ***Hippophae rhamnoides*** | |
| 41505 62965 | behind beach - head of a slack, big patch |
| 41981 62782 | near Slack 4 |

There are some plants of the recumbent species *Cotoneaster integrifolius* on the dunes along the forest edge and a large plant in Slack 2. I have reported on these in Loxton (2013) and they do not seem to be spreading. However for the first time I found two plants each of the invasive species *Cotoneaster franchetti* and *Cotoneaster simonsii* out on the dunes (Photos 19 & 20) – three of these plants were dug out. These two species are highly invasive in the forest and in spite of being a bit wind blasted (Photo 19) they were setting seed. Also for the first time I came across three plants of *Clematis vitalba* (Photo 21). These are not large plants, such as those on the high dunes behind Traeth Penrhos but could be seen easily in July when the bright green foliage stands out among the browning dune grasses.

It is worth noting perhaps the presence of two patches of plants Columbine, *Aquilegia vulgaris* and Michaelmas Daisy, *Aster ?lanceolatus* (Photos 22 & 23). There are patches of each of these plants between Slacks 3 and 4 at 42119 63021 and 42088 63003 respectively. The patch of Michaelmas Daisies is extensive, some 16m x 10m. These patches of commonly cultivated garden plants are close to one another and are perhaps the product of some deliberate introduction.

## 10.5. Appendix E: Fidelity grade, conservation status and habitat code for the dune invertebrate assemblage at Newborough Warren – Ynys Llanddwyn SSSI. The assemblage currently comprises 208 species, including 29 Grade 1, 67 Grade 2 and 112 Grade 3 species. Grade 1 species are emboldened. The 20 pioneer dune slack species are highlighted in red. Data provided by NRW invertebrate ecologists. The dune habitats relating to each Dune Code are given in Appendix G.

| Grade | Species | Order | Family | Status | Dune Code |
|---|---|---|---|---|---|
| 3 | *Dolichopus acuticornis* | Diptera | Dolichopodidae | Local | SD001 |
| 3 | *Coenosia verrallii* | Diptera | Muscidae | Notable/Nb | SD001 |
| 2 | *Arena tabida* | Coleoptera | Staphylinidae | pRDBK | SD001 |
| **1** | ***Neurigona biflexa*** | **Diptera** | **Dolichopodidae** | **RDB I** | **SD001** |
| 2 | *Gabrius exiguous* | Coleoptera | Staphylinidae | RDB I | SD001 |
| 2 | *Delia penicillosa* | Diptera | Anthomyiidae | Unknown | SD001 |
| 2 | *Phytosus spinifer* | Coleoptera | Staphylinidae | | SD001 |
| 2 | *Atheta exigua* | Coleoptera | Staphylinidae | | SD001 |
| 2 | *Philygria punctatonervosa* | Diptera | Ephydridae | | SD001 |
| 3 | *Spilogona veterrima* | Diptera | Muscidae | | SD001 |
| 3 | *Coenosia lacteipennis* | Diptera | Muscidae | | SD001 |
| 3 | *Limnophora scrupulosa* | Diptera | Muscidae | Notable/Nb | SD110 |
| 3 | *Dyschirius salinus* | Coleoptera | Carabidae | Local | SD430 |
| 3 | *Heterocerus flexuosus* | Coleoptera | Heteroceridae | Local | SD430 |
| 2 | *Syntormon filiger* | Diptera | Dolichopodidae | Notable/Nb | SD430 |
| 3 | *Bembidion clarki* | Coleoptera | Carabidae | Notable/Nb | SD430 |
| 3 | *Gabrius osseticus* | Coleoptera | Staphylinidae | Notable/Nb | SD430 |
| 3 | *Pherbellia grisescens* | Diptera | Sciomyzidae | Notable/Nb | SD430 |
| 2 | *Thinobius brevipennis* | Coleoptera | Staphylinidae | pRDBK | SD430 |
| 2 | *Bledius longulus* | Coleoptera | Staphylinidae | Local | SD435 |
| 2 | *Bledius subniger* | Coleoptera | Staphylinidae | Local | SD435 |
| 3 | *Dyschirius thoracicus* | Coleoptera | Carabidae | Local | SD435 |
| 3 | *Bledius fergussoni* | Coleoptera | Staphylinidae | Local | SD435 |
| 3 | *Bledius opacus* | Coleoptera | Staphylinidae | Local | SD435 |
| 3 | *Dyschirius politus* | Coleoptera | Carabidae | Local | SD435 |
| 2 | *Bembidion pallidipenne* | Coleoptera | Carabidae | Notable/Nb | SD435 |
| 3 | *Asaphidion pallipes* | Coleoptera | Carabidae | Notable/Nb | SD435 |
| **1** | ***Nephrotoma quadristriata*** | **Diptera** | **Tipulidae** | **pRDB2** | **SD435** |
| 2 | *Dryops nitidulus* | Coleoptera | Dryopidae | pRDB3 | SD435 |
| 3 | *Dryops striatellus* | Coleoptera | Dryopidae | pRDB3 | SD435 |
| 2 | *Bledius fuscipes* | Coleoptera | Staphylinidae | (local) | SD435 |
| **1** | ***Coranus woodroffei*** | **Hemiptera** | **Reduviidae** | **Local** | **SD440** |
| **1** | ***Helina protuberans*** | **Diptera** | **Muscidae** | **Local** | **SD440** |
| 2 | *Harpalus neglectus* | Coleoptera | Carabidae | Local | SD440 |
| 2 | *Gonia ornata* | Diptera | Tachinidae | Local | SD440 |
| 2 | *Anoplius viaticus* | Hymenoptera | Pompilidae | Local | SD440 |
| 2 | *Zelotes electus* | Araneae | Gnaphosidae | Local | SD440 |
| 2 | *Orthocephalus coriaceus* | Hemiptera | Miridae | Local | SD440 |
| 3 | *Alydus calcaratus* | Hemiptera | Alydidae | Local | SD440 |
| 3 | *Amara bifrons* | Coleoptera | Carabidae | Local | SD440 |
| 3 | *Amara convexior* | Coleoptera | Carabidae | Local | SD440 |
| 3 | *Notoxus monocerus* | Coleoptera | Anthicidae | Local | SD440 |
| 3 | *Acrosathe annulata* | Diptera | Therevidae | Local | SD440 |
| 3 | *Argenna subnigra* | Araneae | Dictynidae | Local | SD440 |
| 3 | *Cheiracanthium virescens* | Araneae | Clubionidae | Local | SD440 |
| 3 | *Liorhyssus hyalinus* | Hemiptera | Rhopalidae | Local | SD440 |

| | | | | | |
|---|---|---|---|---|---|
| 3 | *Amara tibialis* | Coleoptera | Carabidae | Local | SD440 |
| 3 | *Harpalus tardus* | Coleoptera | Carabidae | Local | SD440 |
| 3 | *Byrrhus pustulatus* | Coleoptera | Byrrhidae | Local | SD440 |
| 3 | *Ceropales maculate* | Hymenoptera | Pompilidae | Local | SD440 |
| 3 | *Coelioxys elongate* | Hymenoptera | Megachilidae | Local | SD440 |
| 3 | *Amara convexiuscula* | Coleoptera | Carabidae | Local | SD440 |
| **1** | ***Anthicus bimaculatus*** | **Coleoptera** | **Anthicidae** | **Na** | **SD440** |
| 2 | *Colletes marginatus* | Hymenoptera | Colletidae | Na | SD440 |
| 2 | *Nabis pseudoferus* | Hemiptera | Nabidae | Notable/Nb | SD440 |
| 2 | *Calathus ambiguous* | Coleoptera | Carabidae | Notable/Nb | SD440 |
| 2 | *Oxypoda lurida* | Coleoptera | Staphylinidae | Notable/Nb | SD440 |
| 2 | *Amara lucida* | Coleoptera | Carabidae | Notable/Nb | SD440 |
| 2 | *Orthocerus clavicornis* | Coleoptera | Colydiidae | Notable/Nb | SD440 |
| 2 | *Haplodrassus dalmatensis* | Araneae | Gnaphosidae | Notable/Nb | SD440 |
| 3 | *Dicranocephalus agilis* | Hemiptera | Stenocephalidae | Notable/Nb | SD440 |
| 3 | *Crypticus quisquilius* | Coleoptera | Tenebrionidae | Notable/Nb | SD440 |
| 3 | *Podalonia hirsuta* | Hymenoptera | Sphecidae | Notable/Nb | SD440 |
| 3 | *Megalonotus praetextatus* | Hemiptera | Lygaeidae | Notable/Nb | SD440 |
| 3 | *Amara praetermissa* | Coleoptera | Carabidae | Notable/Nb | SD440 |
| **1** | ***Perilampus aureoviridis*** | **Hymenoptera** | **Chalcidae** | **Unknown** | **SD440** |
| 2 | *Zaira cinerea* | Diptera | Tachinidae | Unknown | SD440 |
| 3 | *Sarcophaga hirticrus* | Diptera | Sarcophagidae | Unknown | SD440 |
| 3 | *Kissister minimus* | Coleoptera | Histeridae | Unknown | SD440 |
| **1** | ***Melanimon tibialis*** | **Coleoptera** | **Tenebrionidae** | **Local** | **SD445** |
| 2 | *Philopedon plagiatum* | Coleoptera | Curculionidae | Local | SD445 |
| 3 | *Pompilus cinereus* | Hymenoptera | Pompilidae | Local | SD445 |
| 3 | *Evagetes crassicornis* | Hymenoptera | Pompilidae | Local | SD445 |
| 3 | *Anoplius infuscatus* | Hymenoptera | Pompilidae | Local | SD445 |
| 3 | *Episyron rufipes* | Hymenoptera | Pompilidae | Local | SD445 |
| 3 | *Ammophila sabulosa* | Hymenoptera | Sphecidae | Local | SD445 |
| 3 | *Andrena barbilabris* | Hymenoptera | Andrenidae | Local | SD445 |
| 3 | *Sphecodes pellucidus* | Hymenoptera | Halictidae | Local | SD445 |
| 3 | *Arachnospila wesmaeli* | Hymenoptera | Pompilidae | Na | SD445 |
| 3 | *Megachile maritima* | Hymenoptera | Megachilidae | (local) | SD445 |
| **1** | ***Aegialia arenaria*** | **Coleoptera** | **Scarabaeidae** | **Local** | **SD450** |
| 2 | *Dryudella pinguis* | Hymenoptera | Sphecidae | Local | SD450 |
| 2 | *Senotainia conica* | Diptera | Sarcophagidae | Local | SD450 |
| 2 | *Tachysphex nitidus* | Hymenoptera | Sphecidae | Local | SD450 |
| 3 | *Metabletus truncatellus* | Coleoptera | Carabidae | Local | SD450 |
| 3 | *Philonicus albiceps* | Diptera | Asilidae | Local | SD450 |
| 3 | *Thereva bipunctata* | Diptera | Therevidae | Local | SD450 |
| 3 | *Myrmosa atra* | Hymenoptera | Tiphiidae | Local | SD450 |
| 3 | *Tachysphex pompiliformis* | Hymenoptera | Sphecidae | Local | SD450 |
| 3 | *Crabro cribrarius* | Hymenoptera | Sphecidae | Local | SD450 |
| 3 | *Crabro peltarius* | Hymenoptera | Sphecidae | Local | SD450 |
| 3 | *Harpactus tumidus* | Hymenoptera | Sphecidae | Local | SD450 |
| 3 | *Epeolus cruciger* | Hymenoptera | Anthophoridae | Local | SD450 |
| 3 | *Epeolus variegatus* | Hymenoptera | Anthophoridae | Local | SD450 |
| 3 | *Calathus mollis* | Coleoptera | Carabidae | Local | SD450 |
| 2 | *Oxybelus argentatus* | Hymenoptera | Sphecidae | Na | SD450 |
| 2 | *Oxybelus mandibularis* | Hymenoptera | Sphecidae | Na | SD450 |
| 3 | *Nysson dimidiatus* | Hymenoptera | Sphecidae | Notable/Nb | SD450 |
| 2 | *Megachile dorsalis* | Hymenoptera | Megachilidae | Notable/Nb | SD450 |
| 2 | *Mecopisthes peusi* | Araneae | Linyphiidae | Notable/Nb | SD450 |

| | | | | | |
|---|---|---|---|---|---|
| 2 | *Hedychridium cupreum* | Hymenoptera | Chrysididae | Notable/Nb | SD450 |
| **1** | ***Colletes cunicularius*** | **Hymenoptera** | **Colletidae** | **RDB3** | **SD450** |
| **1** | ***Sitona griseus*** | **Coleoptera** | **Curculionidae** | **Local** | **SD460** |
| 2 | *Neides tipularius* | Hemiptera | Berytinidae | Local | SD460 |
| 2 | *Kelisia sabulicola* | Hemiptera | Delphacidae | Local | SD460 |
| 3 | *Thyreocoris scarabaeoides* | Hemiptera | Cydnidae | Local | SD460 |
| 3 | *Corizus hyoscyami* | Hemiptera | Rhopalidae | Local | SD460 |
| 3 | *Berytinus crassipes* | Hemiptera | Berytinidae | Local | SD460 |
| 3 | *Meligethes planiusculus* | Coleoptera | Nitidulidae | Local | SD460 |
| 3 | *Protapion ononidis* | Coleoptera | Apionidae | Local | SD460 |
| 3 | *Holotrichapion ononis* | Coleoptera | Apionidae | Local | SD460 |
| 3 | *Chionodes fumatella* | Lepidoptera | Gelechiidae | Local | SD460 |
| 3 | *Pelenomus zumpti* | Coleoptera | Curculionidae | Na | SD460 |
| 3 | *Ceutorhynchus atomus* | Coleoptera | Curculionidae | Na | SD460 |
| 2 | *Protapion dissimile* | Coleoptera | Apionidae | Notable/Nb | SD460 |
| 2 | *Hypera dauci* | Coleoptera | Curculionidae | Notable/Nb | SD460 |
| 3 | *Gronops lunatus* | Coleoptera | Curculionidae | Notable/Nb | SD460 |
| 3 | *Mecinus circulatus* | Coleoptera | Curculionidae | Notable/Nb | SD460 |
| 3 | *Eumerus sabulonum* | Diptera | Syrphidae | Notable/Nb | SD460 |
| 3 | *Glocianus punctiger* | Coleoptera | Curculionidae | Notable/Nb | SD460 |
| 3 | *Bryotropha desertella* | Lepidoptera | Gelechiidae | Unknown | SD460 |
| **1** | ***Psylliodes marcida*** | **Coleoptera** | **Chrysomelidae** | **Local** | **SD500** |
| 3 | *Hilara lundbecki* | Diptera | Empididae | Local | SD500 |
| 3 | *Villeneuvia aestuum* | Diptera | Muscidae | Local | SD500 |
| **1** | ***Agrotis ripae*** | **Lepidoptera** | **Noctuidae** | **Notable/Nb** | **SD500** |
| 2 | *Coenosia minutalis* | Diptera | Muscidae | Notable/Nb | SD500 |
| **1** | ***Luperina nickerlii gueneei*** | **Lepidoptera** | **Noctuidae** | **RDB2** | **SD500** |
| **1** | ***Trigonotylus psammaecolor*** | **Hemiptera** | **Miridae** | **Notable/Nb** | **SD500** |
| **1** | ***Otiorhynchus atroapterus*** | **Coleoptera** | **Curculionidae** | **Local** | **SD510** |
| 2 | *Psammotettix sabulicola* | Hemiptera | Cicadellidae | Local | SD510 |
| 3 | *Nephrotoma submaculosa* | Diptera | Tipulidae | Local | SD510 |
| 3 | *Arctosa perita* | Araneae | Lycosidae | Local | SD510 |
| 3 | *Pelecopsis nemoralioides* | Araneae | Linyphiidae | Local | SD510 |
| **1** | ***Chrysopa abbreviata*** | **Neuroptera** | **Chrysopidae** | **Notable/Nb** | **SD510** |
| **1** | ***Cylindrinotus pallidus*** | **Coleoptera** | **Tenebrionidae** | **Notable/Nb** | **SD510** |
| **1** | ***Eutropha fulvifrons*** | **Diptera** | **Chloropidae** | **Notable/Nb** | **SD510** |
| 2 | *Cardiophorus asellus* | Coleoptera | Elateridae | Notable/Nb | SD510 |
| 2 | *Tetanops myopinus* | Diptera | Ulidiidae | Notable/Nb | SD510 |
| 3 | *Achaearanea riparia* | Araneae | Theridiidae | Notable/Nb | SD510 |
| 3 | *Marpissa nivoyi* | Araneae | Salticidae | Notable/Nb | SD510 |
| 3 | *Ceratinopsis romana* | Araneae | Linyphiidae | Notable/Nb | SD510 |
| 2 | *Mimumesa littoralis* | Hymenoptera | Sphecidae | RDB3 | SD510 |
| **1** | ***Siphona variata*** | **Diptera** | **Tachinidae** | | **SD510** |
| 2 | *Meromyza pratorum* | Diptera | Chloropidae | | SD510 |
| 3 | *Chamaemyia flavipalpis* | Diptera | Chamaemyiidae | | SD510 |
| **1** | ***Anomala dubia*** | **Coleoptera** | **Scarabaeidae** | **Local** | **SD520** |
| 2 | *Xerolycosa miniata* | Araneae | Lycosidae | Local | SD520 |
| 3 | *Sarcophaga filia* | Diptera | Sarcophagidae | Local | SD520 |
| 3 | *Troxochrus scabriculus* | Araneae | Linyphiidae | Local | SD520 |
| 3 | *Cochlicella acuta* | Mollusca | Helicidae | Local | SD520 |
| 3 | *Harpalus anxius* | Coleoptera | Carabidae | Local | SD520 |
| 3 | *Agrypnus murinus* | Coleoptera | Elateridae | Local | SD520 |
| 3 | *Cryptocephalus hypochaeridis* | Coleoptera | Chrysomelidae | Local | SD520 |
| 3 | *Agrotis vestigialis* | Lepidoptera | Noctuidae | Local | SD520 |

| | | | | | |
|---|---|---|---|---|---|
| 3 | *Tiphia femorata* | Hymenoptera | Tiphiidae | Local | SD520 |
| 3 | *Osmia aurulenta* | Hymenoptera | Megachilidae | Local | SD520 |
| **1** | ***Phthiria pulicaria*** | **Diptera** | **Bombyliidae** | **Notable/Nb** | **SD520** |
| 2 | *Orthochaetes insignis* | Coleoptera | Curculionidae | Notable/Nb | SD520 |
| 2 | *Ceutorhynchus hirtulus* | Coleoptera | Curculionidae | Notable/Nb | SD520 |
| 3 | *Cryptocephalus aureolus* | Coleoptera | Chrysomelidae | Notable/Nb | SD520 |
| **1** | ***Dialineura anilis*** | **Diptera** | **Therevidae** | **pRDB3** | **SD520** |
| **1** | ***Pamponerus germanicus*** | **Diptera** | **Asilidae** | **pRDB3** | **SD520** |
| 2 | *Thereva fulva* | Diptera | Therevidae | pRDB3 | SD520 |
| **1** | ***Delia albula*** | **Diptera** | **Anthomyiidae** | **Unknown** | **SD520** |
| **1** | ***Delia pallipennis (candens)*** | **Diptera** | **Anthomyiidae** | **Unknown** | **SD520** |
| 3 | *Chorosoma schillingi* | Hemiptera | Rhopalidae | Local | SD521 |
| 3 | *Agallia laevis* | Hemiptera | Cicadellidae | Local | SD521 |
| 3 | *Dysmachus trigonus* | Diptera | Asilidae | Local | SD521 |
| 3 | *Ectobius panzeri* | Dictyoptera | Pseudomopidae | Notable/Nb | SD521 |
| 2 | *Bryotropha umbrosella* | Lepidoptera | Gelechiidae | Local | SD545 |
| 2 | *Bryotropha mundella* | Lepidoptera | Gelechiidae | Local | SD545 |
| 3 | *Chrysomela populi* | Coleoptera | Chrysomelidae | Local | SD545 |
| 2 | *Anacampsis temerella* | Lepidoptera | Gelechiidae | Na | SD545 |
| 2 | *Monosynamma sabulicola* | Hemiptera | Miridae | Notable/Nb | SD545 |
| 2 | *Pherbellia nana* | Diptera | Sciomyzidae | Notable/Nb | SD545 |
| 2 | *Aphodius plagiatus* | Coleoptera | Scarabaeidae | Notable/Nb | SD545 |
| 3 | *Globiceps cruciatus* | Hemiptera | Miridae | Notable/Nb | SD545 |
| 3 | *Actebia praecox* | Lepidoptera | Noctuidae | Notable/Nb | SD545 |
| 3 | *Dolichopus notatus* | Diptera | Dolichopodidae | Notable/Nb | SD545 |
| 3 | *Gabrius keysianus* | Coleoptera | Staphylinidae | Notable/Nb | SD545 |
| 2 | *Paederus caligatus* | Coleoptera | Staphylinidae | RDB3 | SD545 |
| 2 | *Cleonis pigra* | Coleoptera | Curculionidae | Notable/Nb | SD590 |
| 3 | *Cheilosia mutabilis* | Diptera | Syrphidae | Notable/Nb | SD590 |
| 3 | *Xysticus kochi* | Araneae | Thomisidae | Local | SD720 |
| 3 | *Epiblema incarnatana* | Lepidoptera | Tortricidae | Notable/Nb | SD720 |
| **1** | ***Leiodes furva*** | **Coleoptera** | **Leiodidae** | **Notable/Nb** | **SD830** |
| 2 | *Leiodes ciliaris* | Coleoptera | Leiodidae | Notable/Nb | SD830 |
| 2 | *Trixoscelis obscurella* | Diptera | Heleomyzidae | Local | SD910 |
| 3 | *Onthophagus similis* | Coleoptera | Scarabaeidae | Local | SD910 |
| 2 | *Hypocaccus rugiceps* | Coleoptera | Histeridae | Na | SD910 |
| **1** | ***Baeckmanniolus dimidiatus*** | **Coleoptera** | **Histeridae** | **Notable/Nb** | **SD910** |
| 2 | *Saprinus cuspidatus* | Coleoptera | Histeridae | Notable/Nb | SD910 |
| 3 | *Hypocaccus rugifrons* | Coleoptera | Histeridae | Notable/Nb | SD910 |
| 3 | *Silpha obscura* | Coleoptera | Silphidae | pRDB2 | SD910 |
| **1** | ***Phylan gibbus*** | **Coleoptera** | **Tenebrionidae** | **Local** | **SD930** |
| **1** | ***Phaleria cadaverina*** | **Coleoptera** | **Tenebrionidae** | **Local** | **SD930** |
| 2 | *Anotylus maritimus* | Coleoptera | Staphylinidae | Local | SD930 |
| 2 | *Phytosus balticus* | Coleoptera | Staphylinidae | Local | SD930 |
| 3 | *Bembidion normannum* | Coleoptera | Carabidae | Local | SD930 |
| 3 | *Pogonus chalceus* | Coleoptera | Carabidae | Local | SD930 |
| 3 | *Helcomyza ustulata* | Diptera | Helcomyzidae | Local | SD930 |
| 3 | *Broscus cephalotes* | Coleoptera | Carabidae | Local | SD930 |
| 2 | *Dyschirius nitidus* | Coleoptera | Carabidae | Na | SD930 |
| 2 | *Dyschirius impunctipennis* | Coleoptera | Carabidae | Notable/Nb | SD930 |
| 2 | *Armadillidium album* | Isopoda | Armadillidiidae | Notable/Nb | SD930 |
| 3 | *Argenna patula* | Araneae | Dictynidae | Notable/Nb | SD930 |
| 2 | *Halacritus punctum* | Coleoptera | Histeridae | pRDBK | SD930 |
| 3 | *Nacerdes melanura* | Coleoptera | Oedemeridae | Local | SD935 |

## 10.6. Appendix F: Dune habitat categories (as utilised in KHEPrI "Key Habitat Evaluation Programme for Invertebrates" (A.P. Fowles, in prep.).

| Dune Code | Dune Habitats |
|---|---|
| SD110 | dune pools & sandy streams |
| SD430 | bare mud in mature dune slacks, saltmarsh transition, pool margins, etc. |
| SD435 | wet or damp bare and sparsely vegetated sand (pioneer dune slacks etc.) |
| SD440 | dry bare/sparsely vegetated sand |
| SD445 | dry bare or sparsely vegetated loose sand (mainly fore-dunes) |
| SD450 | dry bare or sparsely vegetated firm sand (blow-outs, margins of paths, etc.) |
| SD460 | phytophagous on low plants in open sand |
| SD500 | beach flora (Cakile, Beta, Agropyron, etc.) |
| SD510 | tussocks/litter in yellow dunes (marram and lyme grass) |
| SD520 | dry herb-rich grassland (fixed dune) |
| SD521 | tall sward dune grassland |
| SD545 | wet or damp vegetated areas (mature dune slacks etc.), inc. creeping willow |
| SD590 | ruderals (thistles, Epilobium) |
| SD720 | dune scrub (hawthorn, burnet rose) |
| SD830 | dune fungi |
| SD910 | dung or carrion on sand |
| SD921 | bee & wasp nests |
| SD930 | strandline (including accumulations of decaying seaweed) & lower shore |
| SD935 | Driftwood |

## 10.7. Data Archive Appendix

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] Species records, which are held on the NRW Recorder 6 database.

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue http://libcat.naturalresources.wales or http://catllyfr.cyfoethnaturiol.cymru by searching 'Dataset Titles'. The metadata is held as record no 115896.

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