THE WASPS AND BEES (HYM., ACULEATA) OF STRENSALL COMMON IN WATSONIAN YORKSHIRE REVISITED

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A report of the aculeate wasps and bees of the lowland heath of Strensall Common, mainly from the 1970s and early 1980s, is given by Archer (1988) with some corrections (Archer, 1992). During the 2000s, it was decided to make a repeat or later study, to investigate possible species differences between the studies.

Strensall Common is a site of 690ha situated about six miles north-east of York (SE65). It is one of the few remaining lowland heathlands in the Vale of York and has been declared a Site of Special Scientific Interest (SSSI). The site is overlain by fluvial sands which have probably been moved by the wind, and now forms a fossil dune landscape. The sandy heath was acquired by the Government in 1881 for military purposes (Wilkinson, 1906), and much drainage work was carried out by the army so that the heath could be used for training purposes. The open drains empty into a stream with steep, often bare, sides. The sides of the drainage ditches, stream and dug holes, when in sunny positions, have provided nesting sites for the subterranean nesters. Rabbit activity and paths have also resulted in bare sandy areas. Silver birch, Scots pine and oak have invaded the drier parts of the heath and sheep-grazing and fires have kept much of the site open. The dead trees, particularly the Scots pine, have been used by aerial nesting species in sunny situations. The Yorkshire Wildlife Trust owns about 42.5ha and its policy of periodically removing trees and tall shrubs from the drier areas has had a beneficial effect on the wasp and bee species. Recently there has been a further removal of trees from the military area.

SAMPLING METHODS

Between 2004 and 2009, 45 visits were made to Strensall Common. Because of the large size of the Common and limited favourable weather conditions, it could take up to three visits to complete a survey of the Common. The 45 visits, therefore, can be reduced to 25 complete surveys. These complete surveys were distributed as follows: April (3), May (5), June (5), July (6), August (5) and September (1). During each survey, all species of aculeate wasps and bees were recorded and usually collected with a hand net for later identification. These records represent the Archer later sample. During this later study, J.A.J. Mortimer contributed records of two ant species.

Since the time of the former study, all the records have been placed on an electronic database which allows and requires a new appraisal of the data. The database records that the author visited the Common 79 times between 1967 and 1985 distributed as follows: April (6), May (19), June

(14), July (19), August (13) and September (8). It is likely, as in the later study, that each visit was only to a part of the Common. It is not now possible to combine these visits so as to give the number of surveys. These records represent the Archer former sample. In addition to the records of five other recorders mentioned in Archer (1988), records from a further six authors have been found (R. Crossley, A. Grayson, W. Hewitt, R.S. Key, K.G. Payne and R.W.J. Uffen). On these visits by other recorders generally only one to three species were recorded, so that there may have been some selection in recording. During this former study, ant records were contributed by M.E. Archer and D.T. Richardson and the record of *Bombus muscorum* by M.E. Archer was from 1976. The records of Archer and other recorders for the former study may be called the 'all-former sample'.

THE NUMBER OF SPECIES

Table 1 shows the number of solitary species recorded from the Archer former and later samples, the all-former sample and for the combined samples. The most species rich family of solitary wasps in all samples was the Crabronidae followed by the Pompilidae. The most species rich families of solitary bees in the all-former sample were Andrenidae and Halictidae and in the Archer later sample the Andrenidae, Halictidae and Apidae. In total, 21 social species (six ant, four social wasps and eleven social bees) were recorded. A full list of species recorded is given in the Appendix. In the following account, the nomenclature is mainly according to Kloet and Hincks (1978) with an up-to-date checklist from the Bees, Wasps and Ants Recording Society (BWARS) web pages at http://www.bwars.com.

The total number of solitary species recorded in the all-former (97) and Archer later (98) samples are similar, although the former Archer study has 19 fewer species (Table 1). The total number of aculeates from the all-former and Archer later samples, including the social species, is 147 (126 solitary, 21 social species). The increase in the combined total number of solitary species was a consequence of different species being recorded in the former and later studies. Only 28 species were found in both the all-former and Archer later samples, so only just over half of the solitary species (55.2%) were recorded in both samples.

From the Archer later study the number of solitary species recorded per month was: April (6.3, range 4–8), May (13.6, 10–18), June (18.2, 13–27), July (14.2, 5–21), August (11.0, 4–19) and September (7). The best month for recording species was June with no peak during August which might have been expected with the flowering of heather, the characteristic plant of lowland heaths.

SPECIES QUALITY

According to Shirt (1987), six Red Data Species (*Crossocerus leucostomus, Ectemnius ruficornis, Pemphredon morio, Andrena ruficrus,*

TABLE 1 — THE NUMBER OF SPECIES OF SOLITARY ACULEATE WASPS AND BEES FROM STRENSALL COMMON OF THE ALL-FORMER AND ARCHER FORMER AND LATER SAMPLES

	Archer Former	All Former	Archer Later	Combined Data
Solitary Wasps				
Chrysididae	5	5	3	6
Tiphiidae	1	1	0	1
Mutillidae	1	1	1	1
Pompilidae	10	11	7	11
Eumeninae	4	5	3	6
Sphecidae	1	1	1	1
Crabronidae	25	32	26	38
Total Solitary Wasps	47	56	41	64
Solitary Bees				
Colletidae	1	3	6	6
Andrenidae	10	13	16	16
Halictidae	9	11	14	15
Megachilidae	5	6	6	9
Apidae	6	8	15	16
Total Solitary Bees	31	41	57	62
Total Solitary Species	78	97	98	126

Nomada lathburiana, N. roberjeotiana) were recorded from the Common. Falk (1991) downgraded three of these species (*C. leucostomus* to National Notable A(Na) status, and *E. ruficornis* and *P. morio* to National Notable B(Nb) status) and indicated that *Crossocerus binotatus* and *Nomada integra* should have Na status and *Methocha articulata, Priocnemis schioedtei, Sphecodes crassus* and *S. ferruginatus* should have Nb status.

Recent work carried out by BWARS indicates that three species (*Priocnemis schioedtei, Ectemnius ruficornis* and *Nomada lathburiana*) should lose their national status and a further two species should be given a national status (*Caliadurgus fasciatellus* and *Anoplius viaticus*).

To take account of these changes, Archer (1999, 2002) has developed a national quality scoring system of high and low quality scoring species. High quality species have a scarce (equivalent to Nb), rare (equivalent to Na) or very rare (equivalent to RDB) status while low quality species have a universal, widespread or restricted status. According to this national system, recorded from the Common are two very rare species (*Crossocerus leucostomus, Andrena ruficrus*), three rare species (*Passaloecus monilicornis, Nomada integra, N. robertjeotiana*) and seven scarce species (*Methocha articulata, Caliadurgus fasciatellus, Anoplius viaticus, Pemphredon morio, Crossocerus binotatus, Sphecodes crassus,*

TABLE 2 — THE ARCHER NATIONAL QUALITY SCORES FOR SOLITARY SPECIES OF THE ALL-FORMER AND ARCHER LATER SAMPLES FROM STRENSALL COMMON

National status	Status value (A)	No. species (B)		Quality scores (A × B)	
		All-Former	Archer Later	All-Former	Archer Later
Universal	1	63	60	63	60
Widespread	2	25	31	50	62
Scarce	8	5	3	40	24
Rare	16	2	2	32	32
Very Rare	32	2	2	64	64
Total		97	98	249	242
Species Quality Score (SQS): All-Former 249/97 = 2.57; Archer Later 242/98 = 2.47					

S. ferruginatus). *Priocnemis schioedtei* has become a universal species and *Ectemnius ruficornis* and *Nomada lathburiana* widespread species.

By weighting the number of each solitary wasp and bee species from the all-former and Archer later samples with the relevant Archer national status value, national quality scores of 249 and 242 respectively can be calculated (Table 2). National species quality scores (SQS) of 2.57 (for all-former) and 2.47 (for Archer later) are derived by dividing the national quality scores by the respective totals for solitary species; i.e. 249/97 and 242/98. Combining all 125 solitary species from the former and later samples gives a quality score of 319 and a species quality score of 2.55 (319/125). Despite an overlap of only 55.2% of solitary species between the former and later samples, the SQSs are a similar value.

Species quality scores are found to be relatively independent of the area of the site under study, so that SQS can be used to compare sites of different areas (Archer, 1999). The SQSs of sites studied in Yorkshire can be placed into one of three classes (Archer, 2003): first class, 2.4–2.9; second class 1.8–2.3; and third class, 1.2–1.7. Therefore Strensall Common can be considered a first class site. Currently, there is only one other first class site in Yorkshire (Crow Wood), although Pollington Quarry could also be so considered (Archer, 2006).

ESTIMATING THE POTENTIAL NUMBER OF SOLITARY WASP AND BEE SPECIES

One of the problems in the study of any site is the difficulty of knowing how many more species are present at a site, but as yet unrecorded. Recent advances in non-parametric statistical procedures offer a way of addressing this problem. The presence/absence estimate of Chao (in Colwell & Coddington, 1994) is based on the number of species observed in one (singleton) or two (doubleton) visits. The First Order Jackknife procedure depends only on the singletons. Because some aculeate species are only active in the spring or summer it is advisable that records be taken

throughout the months of adult activity. The software to carry out the statistical procedure was provided by Pisces Conservation Ltd.

The statistical procedures were run for the former and later Archer samples. The software takes species recorded on 1, 2, etc. visits from 100 random samples of data, each time calculating a mean estimate of potential species diversity. With a small number of visits considered, the estimates are erratic, but as more visits are added the estimates may stabilise giving increased confidence.

The species diversity estimates for the former and later Archer samples are shown in Figs 1 and 2 and Table 3 shows the final species richness estimates after all the visits have been considered. For the former sample, the estimates do stabilise and the two procedures predict similar potential species numbers. For the later sample, the estimates also stabilise but the two procedures generate a greater divergence in potential species numbers.

Cleptoparasitic Load

The cleptoparasitic load (CL) is the percentage of aculeate species that are cleptoparasitic (or parasitoids) on other host aculeates. Wcislo (1987) showed that parasitic behaviour among bees was more numerically pronounced in temperate than tropical regions (N=114 samples, between 5–80°N). Wcislo indicated that parasitic rates are higher in temperate regions, as host populations are more synchronised in their life-history characteristics than in tropical regions. This finding probably does not hold for desert regions where the occurrence of rainfall would tend to synchronise life history characteristics. Wcislo also reviewed the wasp literature, reaching the same conclusion but did not carry out a numerical investigation.

From a review of the literature, Wcislo found that the CLs for bees in Europe varied from 16–33%, a range of 17%. For 26 Yorkshire sites, the CLs for the solitary bees varied from 25.0–40.0%, a range of 15.0% (Archer, unpublished) so supporting Wcislo (1987). The CLs for both the all-former and Archer later samples from Strensall Common fall within this range, although at the upper part of this range (Table 4).

The CLs of solitary wasps from 26 sites also fall within a similar range of 10–25% (Archer, unpublished), so the Wcislo (1987) proposition may also apply to the solitary wasps. The CLs for both the all-former and Archer later samples from Strensall Common also fall within this range, although at the lower part of this range (Table 4).

Aerial Nester Frequency

The aerial-nester frequency (AF) is the percentage of non-parasitic aculeate species that have aerial nest sites. Aerial nesters use old beetle burrows in dead wood, central stem cavities (e.g. bramble), old snail shells, or crevices in cob walls, old mortar, or nests exposed on the surface of rock or other hard material. Subterranean nesters usually excavate their own burrows in the soil, but sometimes adapt existing holes and crevices.

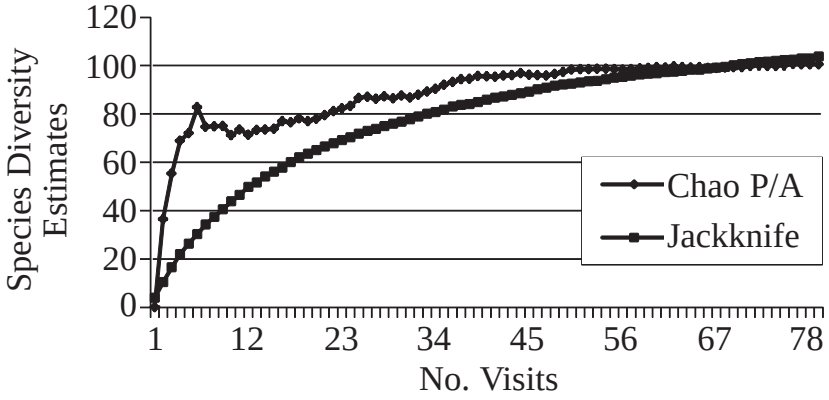

Fig. 1 — The Chao Presence/Absence and First Order Jackknife estimates of solitary species richness of the Archer Former Sample.

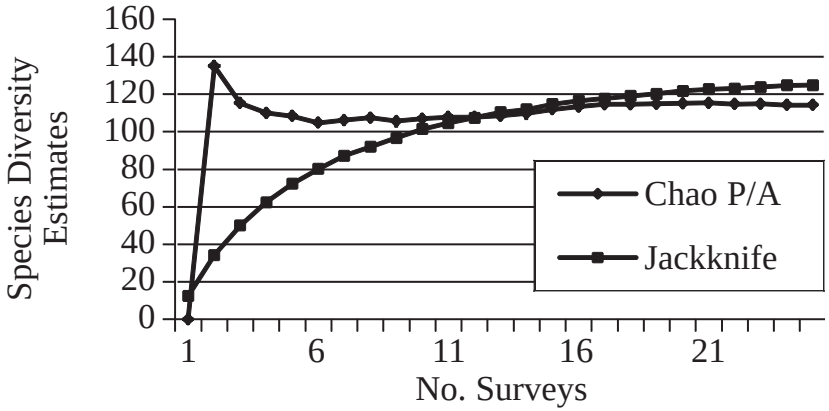

Fig. 2 — The Chao Presence/Absence and First Order Jackknife estimates of solitary species richness of the Archer Later Sample.

The AFs for the all-former and Archer later samples of the solitary species are given in Table 5. The AFs for all the British species of solitary wasps is 46.2% and solitary bees is 17.9%. The AFs for the all-former and Archer later samples are similar to the British AFs except for the solitary bees of the Archer later sample which is higher.

DISCUSSION

The relative lack of solitary species overlap between the all-former and Archer later samples could be a consequence of the loss of species, the

TABLE 3 — NON-PARAMETRIC ESTIMATES OF SPECIES RICHNESS OF SOLITARY SPECIES FOR THE ALL-FORMER AND ARCHER LATER SAMPLES FROM STRENSALL COMMON

	Archer Former		Archer Later	
	Chao	Jackknife	Chao	Jackknife
No. species recorded	78	78	98	98
No. species estimated	101	104	114	125
95% confidence limits	82–119	92–116	100–128	111–138
% of estimated spp. found	77.2	75.0	86.0	78.4

TABLE 4 — THE RELATIVE FREQUENCY OF THE CLEPTOPARASITIC (OR PARASITOID) SPECIES AMONG THE SOLITARY SPECIES OF THE ALL FORMER (A-F) AND ARCHER LATER (AL) SAMPLES FROM STRENSALL COMMON

	No. hosts (H)		No. cleptoparasites (C)		Cleptoparasitic Load CL = 100×C/(H+C)	
	A-F	AL	A-F	AL	A-F	AL
Solitary wasps	49	35	6*	6	10.9	16.6
Solitary bees	26	34	15	23	36.6	40.4

* *Methocha articulata* excluded as its host is non-aculeate

TABLE 5 — THE NESTING HABITS OF THE HOST SPECIES AMONG THE SOLITARY SPECIES OF THE ALL-FORMER (A-F) AND ARCHER LATER (AL) SAMPLES FROM STRENSALL COMMON

	No. subterranean Nesters (S)		No. aerial nesters (A)		Aerial Nester Frequency AF = 100 x A/(S + A)	
	A-F	AL	A-F	AL	A-F	AL
Solitary wasps	25	19	24	16	49.0	45.7
Solitary bees	21	24	5	10	19.2	29.4

appearance of new species or small species populations so that a species is unlikely to be recorded in both samples. From the all-former sample, the frequently recorded *Anoplius viaticus* has been lost from the Archer later sample and the frequently recorded *Pemphredon morio*, *Sphecodes crassus*, *Nomada flava* and *N. integra*, being relatively new species to Yorkshire are likely to be new species additions in the Archer later sample, being absent in the all-former sample. All the other non-overlap species were recorded only on one to three occasions, so probably only existed at

low population levels. The probable existence of these non-overlapping low population level species in both the all-former and later samples can be justified by the known association of parasite (usually cleptoparasite) and host. The parasite might be present in one sample and its host in both samples: *Elampus panzeri* (former) with its possible host *Mimesa equestris*; *Hedychridium ardens* (former) with its host *Tachysphex pompiliformis*; *Chrysis angustula* (former) with its possible host *Ancistrocerus trifasciatus*; *Epeolus variegatus* (former) with its host *Colletes daviesanus*; *Nomada striata* (later) with its host *Andrena wilkella*; and *N. ruficornis* (later) with its host *A. haemorrhoa*. Again, the host might be present in one sample and the parasite in the other sample: host *Argogorytes mystaceus* (former) and parasite *Nysson spinosus* (later). Thus, except for the loss of *Anoplius viaticus* and the relatively new species, the total number of species from the all-former and Archer later samples (Table 1) can be justified as a better measure of the number of solitary species on the Common. Of the social species, only *Bombus muscorum* has been lost from Strensall Common.

If the non-overlap species are so accepted, then perhaps the species diversity estimates should be based on the all-former and Archer later samples. When this is done, stable estimates of 137 species are obtained by the Chao presence/absence procedure and 131 species by the Jackknife procedure. These estimates are probably nearer to reality and, at least, fall within the confidence limit of the Archer later sample (Table 3, Jackknife procedure).

Strensall Common is surrounded by farmland, some of which has been neglected, a stream with deep banks often in sunny situations and a caravan park; a railway line runs through the site. These fringing biotopes could be attracting aculeate species because they have suitable nesting and food resources. It is possible that some of the recorded species are only associated with these fringe biotopes and not with the main lowland heathland characteristics of the Common. For example, an aggregation of *Halictus tumulorum* was only observed in a deep stream bank and the *Hylaeus* species seem to be particularly associated with fringe biotopes. Three of the four *Hylaeus* species were only recorded in the Archer later sample, and since *Hylaeus* are aerial nesters, these species were partly responsible for the higher Aerial Nester Frequency (AF solitary bee index (Table 5)).

The variation of the Cleptoparasitic Load (CL) index may occur for reasons in addition to Wcislo's proposal. The solitary bee parasites' higher CLs could be a consequence of the visual method of recording resulting in the increased visibility of these parasites which tend to remain near the nesting sites of their hosts. This explanation does not hold for the lower CLs of the solitary wasps which accords with the lower population level of solitary wasp parasites. Generally, solitary wasp parasites will have lower population levels as they occupy the fourth link in their food chains while solitary bee parasites form the third link in their food chains.

CONCLUSIONS

1. With 147 recorded species (126 solitary, 21 social) and twelve species of national importance, Strensall Common is one of the few excellent Yorkshire sites for aculeate Hymenoptera.
2. With an overall species quality score of 2.55, Strensall Common is one of the few first class Yorkshire sites of conservation importance.
3. Two species, *Anoplius viaticus* and *Bombus muscorum*, seem to have been lost from Strensall Common and at least four new species have been gained: *Pemphredon morio, Sphecodes crassus, Nomada flava* and *N. integra*.
4. Evidence is presented that many species exist at low population levels so reducing their chances of being recorded.
5. Evidence is presented that fringe habitats make an important contribution to species richness, particularly of aerial nesters, of Strensall Common.

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APPENDIX
SPECIES RECORDED FROM STRENSALL COMMON

CHRYSIDIDAE: *Elampus panzeri* (Fab.), *Hedychridium ardens* (Latreille *in* Coquebert), *Chrysis angustula* Schenck, *C. ignita* (Linn.), *C. impressa* Schenck, *Trichrysis cyanea* (Linn.).
TIPHIIDAE: *Methocha articulata* Latreille.
MUTILLIDAE: *Myrmosa atra* Panzer.
FORMICIDAE: *Formica lemani* Bondroit, *Lasius niger* (Linn.), *Leptothorax acervorum* (Fab.), *Myrmica rubra* (Linn.), *M. ruginodis* Nylander, *M. scabrinodis* Nylander.
POMPILIDAE: *Priocnemis exaltata* (Fab.), *P. parvula* Dahlbom, *P. perturbator* (Harris), *P. schioedtei* Haupt, *Caliadurgus fasciatellus* (Spinola), *Dipogon subintermedius* (Magretti), *Anoplius nigerrimus* (Scopoli), *A. viaticus* (Linn.), *Arachnospila anceps* (Wesmael), *A. spissa* (Schiødte), *Evagetes crassicornis* (Shuckard).
EUMENINAE: *Odynerus spinipes* (Linn.), *Ancistrocerus gazella* (Panzer), *A. oviventris* (Wesmael), *A. parietinus* (Linn.), *A. trifasciatus* (Müller), *Symmorphus bifasciatus* (Linn.).
VESPINAE: *Dolichovespula sylvestris* (Scopoli), *Vespula germanica* (Fab.), *V. rufa* (Linn.), *V. vulgaris* (Linn.).
SPHECIDAE: *Ammophila sabulosa* (Linn.).
CRABRONIDAE: *Tachysphex pompiliformis* (Panzer), *Trypoxylon clavicerum* Lepeletier & Serville, *T. figulus* (Linn.), *Crabro cribrarius* (Linn.), *C. peltarius* (Schreber), *Crossocerus annulipes* (Lepeletier & Brullé), *C. binotatus* Lepeletier & Brullé, *C. capitosus* (Shuckard), *C. cetratus* (Shuckard), *C. dimidiatus* (Fab.), *C. leucostomus* (Linn.), *C. megacephalus* (Rossi), *C. nigritus* (Lepeletier & Brullé), *C. ovalis* Lepeletier & Brullé, *C. podagricus* (Van der Linden), *C. pusillus* Lepeletier & Brullé, *C. quadrimaculatus* (Fab.), *C. tarsatus* (Shuckard), *C. wesmaeli* (Van der Linden), *Ectemnius cavifrons* (Thomson), *E. continuus* (Fab.), *E. cephalotes* (Olivier), *E. lapidarius* (Panzer), *E. ruficornis* (Zetterstedt), *Lindenius albilabris* (Fab,), *Oxybelus uniglumis* (Linn.), *Mimumesa dahlbomi* (Wesmael), *Mimesa equestris* (Fab.), *Pemphredon lethifer* (Shuckard), *P. lugubris* (Fab.), *P. morio* Van der Linden, *Passaloecus corniger* Shuckard, *P. monilicornis* Dahlbom, *P. singularis* Dahlbom, *Mellinus arvensis* (Linn.), *Nysson spinosus* (Forster), *Gorytes tumidus* (Panzer), *Argogorytes mystaceus* (Linn.).
COLLETIDAE: *Colletes daviesanus* Smith, *C. succinctus* (Linn.), *Hylaeus brevicornis* Nylander, *H. communis* Nylander, *H. confusus* Nylander, *H. hyalinatus* Smith.
ANDRENIDAE: *Andrena barbilabris* (Kirby), *A. bicolor* Fab., *A. chrysosceles* (Kirby), *A. cineraria* (Linn.), A. *clarkella* (Kirby), *A. fucata* Smith, *A. fulva* (Müller *in* Allioni), *A. fuscipes* (Kirby), *A. haemorrhoa* (Fab.), *A. nigroaenea* (Kirby), *A. praecox* (Scopoli), *A. ruficrus* Nylander, *A. scotica* Perkins, *A. subopaca* Nylander, *A. tarsata* Nylander, *A. wilkella* (Kirby).
HALICTIDAE: *Halictus tumulorum* (Linn.), *H. rubicundus* (Christ), *Lasioglossum albipes* (Fab.), *L. calceatum* (Scopoli), *L. fratellum* (Pérez), *L. rufitarse* (Zetterstedt), *L. villosulum* (Kirby), *Sphecodes crassus* Thomson, *S. ephippius* (Linn.), *S. ferruginatus* von Hagens, *S. geoffrellus* (Kirby), *S. gibbus* (Linn.), *S. hyalinatus* von Hagens, *S. monilicornis* (Kirby), *S. pellucidus* Smith.
MEGACHILIDAE: *Chelostoma florisomne* (Linn.), *Osmia leaiana* (Kirby), *O. rufa* (Linn.), *Megachile centuncularis* (Linn.), *M. circumcincta* (Kirby), *M. versicolor* Smith, *M. willughbiella* (Kirby), *Coelioxys elongata* Lepeletier, *C. rufescens* Lepeletier & Serville.
APIDAE: *Nomada fabriciana* (Linn.), *N. flava* Panzer, *N. flavoguttata* (Kirby), *N. goodeniana* (Kirby), *N. integra* Brullé, *N. lathburiana* (Kirby), *N. leucophthalma* (Kirby), *N. marshamella* (Kirby), *N. panzeri* Lepeletier, *N. robertjeotiana* Panzer, *N. ruficornis* (Linn.), *N. rufipes* Fab., *N. striata* Fab., *Epeolus cruciger* (Panzer), *E. variegatus* (Linn.), *Anthophora furcata* (Panzer), *Bombus hortorum* (Linn.), *B. lapidarius* (Linn.), *B. lucorum* (Linn.), *B. muscorum* (Linn,), *B. pascuorum* (Scopoli), *B. pratorum* (Linn.), *B. terrestris* (Linn.), *B. bohemicus* (Seidl), *B. sylvestris* (Lepeletier), *B. vestalis* (Geoffroy *in* Fourcroy), *Apis mellifera* Linn.