Phylogeny and host association in *Platygaster* Latreille, 1809

(Hymenoptera, Platygastridae)

Peter Neerup Buhl

Buhl, P.N.: Phylogeny and host association in *Platygaster* Latreille, 1809 (Hymenoptera, Platygastridae).
Ent. Meddr 69: 113-122. Copenhagen, Denmark 2001. ISSN 0013-8851.

An examination of the known midge host/midge plant host associations for species of *Platygaster* parasitoid wasps seems to indicate a number of natural parasitoid species groups restricted to specific plant families. Midge hosts seem less indicative for platygastrid relationships, but several exceptions from this rule exist. The possible reasons for this are discussed. It is also shown that species of *Platygaster* with known host associations generally prefer midges on plant families which are not the families generally prefered by the midges. Furthermore, a comparison of the known midge host/midge plant host associations for the genera of the "*Platygaster*-cluster" and the "*Synopeas*-cluster" shows great differences in the general preferences of the clusters.

P.N. Buhl, Troldhøjvej 3, DK-3310 Ølsted, Denmark. E-mail: pnbuhl@zmuc.ku.dk

Introduction

The phylogeny of the very large platygastrid genus *Platygaster*, tiny parasitoids on gall midges (Diptera, Cecidomyiidae), is mostly unresolved. The great problems which meet the investigator are primarily – as in all platygastrids – the few external characters available in a phylogenetic analysis. A further obstacle in the revisionary work is that many species are known only from short dated original descriptions (unknown or unrevised type material). Aspects of the biology (midge host or host plant of midge) are, however, known for about half the described species, so perhaps this could enlighten aspects of the parasitoid taxonomy - as was successfully done e.g. in Braconidae by Griffiths (1964, 1966a, 1966b). A couple of species groups of *Platygaster* were in fact treated by MacGown (1974, 1979), in particular in the later work, on the basis of host plant association. A general overview of the entire genus with regard to host midge and host plant association combined with taxonomic remarks has, however, to my knowledge never been done. Perhaps for good reasons, considering the above mentioned difficulties. At present an arrangement of the species in *Platygaster* – which is a portmanteau genus most unlikely to be monophyletic (MacGown, 1979) – can only be very tentative and preliminary. But some partial conclusions seem to be possible, helping to construct a conceptual "taxonomic sceleton" which surely need a more solid foundation and a lot more bricks of facts to satisfy, but this can only be provided by many further years of alpha taxonomy.

An overview of host association is also relevant for quite another reason: The only modern catalogue (also with notes on biology), i.e. Vlug (1995), took no regard to modern revisions of cecidomyiid taxonomy and nomenclature, at first hand making comparisons very unclear.

Method

A list of species of *Platygaster* was made with their cecidomyiid hosts and the midge host plants (Table 1; author and year of description only mentioned here). Sorted on the basis of midge genus or midge tribe this list only made limited sense with regard to wasp taxonomy (understood as comparative morphology of the *Platygaster*-species as known first-hand by the author or through the literature). Of course, also the phylogeny of Cecidomyiidae is very unresolved, e.g. Oligotrophini and Cecidomyiini being paraphyletic groups (Roskam, 1992), making a more reliable parameter desirable. Luckily, sorted by host plant family, a – somewhat fragmentary – pattern seemed to emerge. It invites to make several new suggestions on relationships between species not hitherto considered but quite reasonable with view to some key characters (especially of head and thorax, among the most indicative in platygastrids).

Results

Remarks on *Platygaster* associated with

- Betulaceae: The two Palaearctic species *betularia* and *betulae* are indeed very similar in biology as well as in morphology (Roskam, 1986), the Nearctic *columbiana*, however, seems to be rather distant, cf. Fouts (1924).
- Chenopodiaceae: *P. aphidis* and *bonessi* seem to be species sola, but between the Nearctic *P. atriplicis* and the Palaearctic *P. stefaniolae* and *stefaniellae* there seems to be several key characters in common (structure of head and mesoscutum).
- Compositae: It must be noticed that all species here – except four – are from the New World. With regard to the descriptions in Kieffer (1926) it seems that the following Neotropical species are rather similar: *P. baccharidis, caulicola, tumoricola, heterothalami* and probably also *luctuosa*, clearly reflecting the greater importance of plant than of midge association for the phylogeny of the wasps (it is perhaps relevant that all their midge hosts form distinct galls, cf. Kieffer (1926)). Also the Nearctic *astericola, huachucae, variabilis*, and *vernoniae* share plant family association as well as several key morphological characters. The same seems to be the case for *actinomeridis* and *artemisiae* (the record of *actinomeridis* from Cesalpiniaceae is doubtful, cf. Fouts (1924)). In contrast, the most surely closely related *rohweri* and *vernoniae* share neither a closely related midge nor plant. But also *solidaginis, striaticeps*, and *utahensis* which seem to have similar structure of head and mesoscutum are all associated with Compositae.
- Coniferae: MacGown (1979: 16) clearly defined the *P. contorticornis*-group on the peculiar condition of male antennal plate organs (*P. contorticornis, confusa, gahani, ponderosae, shastensis, beneficiens*, and *herricki*). To this should most probably be added *P. plana* Buhl, 1994 and *planoides* Buhl, 1995 (males and biology unknown). *P. rufipes, abicollis*, and *victoriae* form another group on account of antennal plate organ and shape of scutellum according to MacGown (1979). *P. zaragozana* and *juniperi* also form a distinct group based on aberrant shape of metasoma, though also *diplosidis* could belong here. Finally, *P. entwistlei* and *manto* share many morphological traits and association with conifers. *P. distincta* attacks midge species from two genera on the same plant host, *Pinus radiata*. *P. matsutama* is a parasitoid on a midge on the needles of *Pinus*, the very similar *P. sugitama* on a midge on the needles of *Cryptomeria*, both in Japan (a parallel biology should be expected from the very similar *P. lundensis* Buhl, 1997).
- Fabaceae: The similar *P. tuberculi* and *leguminicolae* share midge genus as well as plant family association. (*P. lupinicola* should possibly also be included in this group).
- Fagaceae: There seems to be several key similarities between *P. tumida* and *cynipicola* (in structure of head and thorax). Also, *cynipicola* and *atrae* are very similar, reared from

Table 1. Species of *Platygaster* with known host/plant associations. *Platygaster* names generally according to Vlug (1995). Cecidomyiid names generally according to Gagné (1994) and Skuhravá (1986). Some informations missing or unavailable. Cases of a species just swept on a certain plant not mentioned. Notes: 1) Not host (but probably midge host/prey). 2) New record: *P. sagana* reared from *Rhopalomyia ptarmicae* (Vallot, 1849) on *Achillea ptarmica* L. in Germany (M. Boness leg.).

***Platygaster* species**	**host taxon (genus, tribe)**	**gall type**	**host plant taxon (genus, family)**
abicollis MacGown & Osgood, 1971	*Dasineura*, Oligotrophini	leaf (needle) gall	*Abies*, Coniferae
acciculosis Drake, 1969	*Diarthonomyia*, Oligotrophini	stem/leaf gall	*Chrysanthemum*, Compositae
acciculosis Drake, 1969	*Zeuxidiplosis*, Cecidomyiini	leaf gall	*Hypericum*, Hypericaceae
actinomeridis (Ashmead, 1893)	*Lasioptera*, Lasiopterini		*Gleditsia*, Cesalpiniaceae
actinomeridis (Ashmead, 1893)			*Actinomeris*, Compositae
actinomeridis (Ashmead, 1893)			*Verbesina*, Compositae
americana Ashmead, 1887	*Contarinia*, Cecidomyiini	leaf (needle) gall	*Verbesina*, Compositae
antennariae (Ashmead, 1893)	*Rhopalomyia*, Oligotrophini	bud gall	*Baccharis*, Compositae
aphidis Ashmead, 1893	*Aphis*, Homoptera1)	predatory midge	*Chenopodium*, Chenopodiaceae
apicalis Thomson, 1859	*Lasioptera*, Lasiopterini	stem gall	*Rubus*, Rosaceae
artemisiae (Ashmead, 1893)		gall	*Artemisia*, Compositae
ashmeadiana Huggert, 1973	*Dasineura*, Oligotrophini	cone	*Picea*, Coniferae
ashmeadiana Huggert, 1973	*Chilophaga*, Alycaulini	stem (culm) gall	*Aristida*, Graminaceae
astericola (Ashmead, 1893)		gall	*Aster*, Compositae
asynaptae (Ashmead, 1893)	*Asynapta*, Asynaptini	gall	*Salix*, Salicaceae
athamas Walker, 1835	*Bayeria*, Oligotrophini	bud gall	*Euphorbia*, Euphorbiaceae
athamas Walker, 1835	*Wachtliella*, Oligotrophini	leaf gall	*Rosa*, Rosaceae
athamas Walker, 1835	*Dasineura*, Oligotrophini	terminal bud (unswollen)	*Salix*, Salicaceae
atrae Fouts, 1924	*Procecidochares*, Tephritidae1)	stem gall	*Daucus*, Umbelliferae
atriplicis (Ashmead, 1893)		gall	*Atriplex*, Chenopodiaceae
attenuata Walker, 1835	*Haplodiplosis*, Cecidomyiini	stem depressions	Graminaceae
attenuata Walker, 1835	*Dasineura*, Oligotrophini	flower without swelling	*Alopecurus*, Graminaceae
australis (Dodd, 1916)		bud	*Careya*, Barringtoniaceae
baccharidis Kieffer, 1910	*Cecidomyia*, Cecidomyiini	stem swelling	*Baccharis*, Compositae
beneficiens MacGown, 1979	*Dasineura*, Oligotrophini	cone	*Picea*, Coniferae
betulae (Kieffer, 1916)	*Semudobia*, Oligotrophini	fruit swelling	*Betula*, Betulaceae
betularia Kieffer, 1916	*Semudobia*, Oligotrophini	fruit swelling	*Betula*, Betulaceae
bonessi Buhl, 2000	*Stefaniella*, Lasiopterini	stem gall	*Atriplex*, Chenopodiaceae
brevistriata Kieffer, 1916	*Iteomyia*, Oligotrophini	leaf gall	*Salix*, Salicaceae
burkei (Rohwer, 1917)	*Retinodiplosis*, Cecidomyiini	under bark	*Pinus*, Coniferae
californica (Ashmead, 1893)	*Rhopalomyia*, Oligotrophini	gall	*Baccharis*, Compositae
canestrinii (Rondani, 1866)	*Dasineura*, Oligotrophini	leaf sheat	"cereals", Graminaceae
carinifrons (Brues, 1910)			*Ficus*, Moraceae
caryae Ashmead, 1893	*Caryomyia*, Asphondyliini	gall	*Carya*, Juglandaceae
caulicola Kieffer, 1910	*Meunieriella*, Camptoneuromyiini	stem swelling	*Baccharis*, Compositae
cecconii Kieffer, 1913	*Dasineura*, Oligotrophini	stem without gall	*Salix*, Salicaceae
cecconii Kieffer, 1913	*Psectrosema*, Oligotrophini	stem gall	*Tamarix*, Tamaricaceae
cecidomyiae Ratzeburg, 1852	*Dasineura*, Oligotrophini	stem swelling	*Salix*, Salicaceae
coloradensis (Ashmead, 1893)	*Rhopalomyia*, Oligotrophini	bud gall	*Salvia*, Labiatae
columbiana Fouts, 1924	*Dasineura*, Oligotrophini	bud gall	*Alnus*, Betulaceae
compressicornis (Thomson, 1859)	*Thecodiplosis*, Cecidomyiini	leaf (needle) without gall	*Pinus*, Coniferae
contorticornis Ratzeburg, 1844	*Kaltenbachiola*, Oligotrophini	cone	*Picea*, Coniferae
corni Kieffer, 1916	*Craneiobia*, Oligotrophini	leaf gall	*Cornus*, Cornaceae
coronatus (Brues, 1910)	*Asphondylia*, Asphondyliini		*Mikania*, Compositae
cottei Kieffer, 1913	*Lasioptera*, Lasiopterini	stem gall	*Daucus*, Umbelliferae
cruciferarum Kieffer, 1916	*Dasineura*, Oligotrophini	flower gall	*Raphanus*, Cruciferae
cynipicola (Ashmead, 1893)	*Neuroterus*, Cynipidae1)		*Quercus*, Fagaceae
demades Walker, 1835	*Wachtliella*, Oligotrophini	bud gall	*Erica*, Ericaceae
demades Walker, 1835	*Dasineura*, Oligotrophini	leaf margin rolls	*Malus*, Rosaceae
diplosidis (Ashmead, 1893)	*Retinodiplosis*, Cecidomyiini	leaf (needle) without gall?	*Pinus*, Coniferae
diplosidis (Ashmead, 1893)			*Picea*, Coniferae
diplosisae Risbec, 1956	*Orseolia*, Cecidomyiini	stem gall	*Oryza*, Graminaceae
distincta Fouts, 1926	*Thecodiplosis*, Cecidomyiini	leaf (needle) gall	*Pinus*, Coniferae
distincta Fouts, 1926	*Cecidomyia*, Cecidomyiini	pitch mass	*Pinus*, Coniferae
dryomiae Dieuzeide, 1927	*Dryomyia*, Oligotrophini	leaf gall	*Quercus*, Fagaceae
entwistlei Buhl, 1997	*Oligotrophus*, Oligotrophini	bud gall	*Juniperus*, Coniferae
equestris Spittler, 1969	*Haplodiplosis*, Cecidomyiini	stem depressions	*Agropyron*, Graminaceae
equestris Spittler, 1969	*Haplodiplosis*, Cecidomyiini	stem depressions	*Triticum*, Graminaceae
erdosi (Szelényi, 1958)			*Phragmites*, Graminaceae
ericeti Rondani, 1877	*Dasineura*, Oligotrophini	gall	*Erica*, Ericaceae
eriphyle Walker, 1835	*Rhopalomyia*, Oligotrophini	bud gall	*Artemisia*, Compositae
eryngii Kieffer, 1916	*Lasioptera*, Lasiopterini	stem swelling	*Eryngium*, Umbelliferae
etsuhoae Buhl, 1998	*Etsuhoa*, Cecidomyiini	terminal bud gall	*Juniperus*, Coniferae
eurotiae (Ashmead, 1893)		gall	*Eurotia*, Chenopodiaceae
euurae (Ashmead, 1893)	*Euura*, Tenthredinidae1)		*Salix*, Salicaceae
exigue Fouts, 1926	*Dasineura*, Oligotrophini	gall (on inquiline)	*Salix*, Salicaceae

feltii Fouts, 1920	*Walshomyia,* Oligotrophini	bud swelling	*Cedrus,* Coniferae
floricola (Kieffer, 1916)	*Dasineura,* Oligotrophini	flower swelling	*Raphanus,* Cruciferae
foersteri (Gahan, 1919)	*Orseolia,* Cecidomyiini	stem gall	*Oryza,* Graminaceae
foersteri (Gahan, 1919)		gall	*Ischaemum,* Graminaceae
foutsi Huggert, 1973	*Lestodiplosis,* Cecidomyiini	leaf (needle) without gall	*Pinus,* Coniferae
fungicola Kieffer, 1916	*Peromyia,* Peromyiini		(Fungus)
gahani Fouts, 1924		cone	*Abies,* Coniferae
galenus Walker, 1835		gall	*Halimione,* Chenopodiaceae
generalii Rondani, 1877	*Dasineura,* Oligotrophini	stem without gall	Graminaceae
generalii Rondani, 1877	*Mayetiola,* Oligotrophini	stem without gall	*Triticum,* Graminaceae
globicola Kieffer & Jörgensen, 1910	*Misospatha,* Oligotrophini	gall	*Baccharis,* Compositae
graminis (Kieffer, 1916)	*Lasioptera,* Lasiopterini	stem swelling	*Calamagrostis,* Graminaceae
gyrone Szelényi, 1958	*Giraudiella,* Oligotrophini	stem gall	*Phragmites,* Graminaceae
herrickii Packard, 1841	*Mayetiola,* Oligotrophini	stem without gall	*Triticum,* Graminaceae
herrickii Packard, 1841	*Mayetiola,* Oligotrophini	stem (culm) gall	*Poa,* Graminaceae
heterothalami Kieffer & Jörgensen, 1910	*Meunieriella,* Camptoneuromyiini	gall	*Heterothalamus,* Compositae
hiemalis Forbes, 1888	*Mayetiola,* Oligotrophini	stem without gall	*Triticum,* Graminaceae
hiemalis Forbes, 1888			*Bromus,* Graminaceae
hiemalis Forbes, 1888			*Secale,* Graminaceae
huachucae (Ashmead, 1893)			*Helianthus,* Compositae
hyalinipennis (Ashmead, 1887)	*Caryomyia,* Asphondyliini	leaf gall	*Hicoria,* Juglandaceae
hybrida Buhl, 1994	*Cecidomyia,* Cecidomyiini	resin mass	*Pinus,* Coniferae
hygrophila Kieffer, 1916	*Lasioptera,* Lasiopterini	stem swelling	*Phragmites,* Graminaceae
iolas Walker, 1835	*Dasineura,* Oligotrophini	siliqua swelling	*Brassica,* Cruciferae
iteocrypta Kieffer, 1916	*Dasineura,* Oligotrophini	stem swelling	*Salix,* Salicaceae
iteophilus (Kieffer, 1916)	*Dasineura,* Oligotrophini	bud swelling	*Salix,* Salicaceae
juniperella MacGown, 1979	*Contarinia,* Cecidomyiini	leaf (needle) gall	*Juniperus,* Coniferae
juniperi MacGown, 1979			*Juniperus,* Coniferae
juniperina MacGown, 1979			*Juniperus,* Coniferae
komugi Ishii, 1953	*Sitodiplosis,* Cecidomyiini	flower swelling	Graminaceae
lampronota Fouts, 1924	*Rhopalomyia,* Oligotrophini	flower gall	*Baccharis,* Compositae
lasiopterae Kieffer & Jörgensen, 1910	*Meunieriella,* Camptoneuromyiini	stem gall	*Heterothalamus,* Compositae
leguminicolae Fouts, 1920	*Dasineura,* Oligotrophini	flower without swelling	*Trifolium,* Fabaceae
leptocera Thomson, 1859			(grass), Graminaceae
leucanthemi (Kieffer, 1916)	*Ozirhincus,* Lasiopterini	swollen achenes	*Chrysanthemum,* Compositae
libocedri MacGown, 1974	*Rhopalomyia,* Oligotrophini		*Libocedrus,* Cupressaceae
libocedri MacGown, 1974			*Viscum* (on *Libocedrus*), Loranthaceae
linearis Fouts, 1924	*Lasioptera,* Lasiopterini	leaf/stem without gall?	*Muhlenbergia,* Graminaceae
lineata Kieffer, 1906	*Contarinia,* Cecidomyiini	flower swelling	*Pyrus,* Rosaceae
longestriata Kieffer, 1916	*Dasineura,* Oligotrophini	stem swelling	*Salix,* Salicaceae
longestriata Kieffer, 1916	*Dasineura,* Oligotrophini	leaf gall	*Salix,* Salicaceae
longicaudata (Kieffer, 1906)	*Mayetiola,* Oligotrophini	stem without gall	*Triticum,* Graminaceae
longula (Kieffer, 1926)	*Craneiobia,* Oligotrophini	leaf gall	*Cornus,* Cornaceae
lucida Fouts, 1924	*Dasineura,* Oligotrophini	cone	*Picea,* Coniferae
luctuosa Kieffer & Herbst, 1911	*Dasineura,* Oligotrophini	leaf gall	*Baccharis,* Compositae
lupinicola (Ashmead, 1893)		gall	*Lupinus,* Fabaceae
lyciicola Kieffer, 1910	*Jorgensenia,* Centrodiplosini	stem gall	*Lycium,* Solanaceae
lyciicola Kieffer, 1910	*Lyciomyia,* Oligotrophini	stem gall	*Lycium,* Solanaceae
mainensis MacGown & Osgood, 1971	*Paradiplosis,* Cecidomyiini		*Abies,* Coniferae
mainensis MacGown & Osgood, 1971	*Dasineura,* Oligotrophini	leaf (needle) gall	*Abies,* Coniferae
malpighii Kieffer, 1916	*Craneiobia,* Oligotrophini	leaf gall	*Cornus,* Cornaceae
manto Walker, 1835	*Paradiplosis,* Cecidomyiini	leaf (needle) without gall	*Abies,* Coniferae
marchali Kieffer, 1906	*Dasineura,* Oligotrophini	leaf gall	*Filipendula,* Rosaceae
marchali Kieffer, 1906	*Dasineura,* Oligotrophini	leaf margin rolls	*Pyrus,* Rosaceae
marchali Kieffer, 1906	*Dasineura,* Oligotrophini	leaf gall	*Spiraea,* Rosaceae
matsutama Yoshida & Hirashima, 1979	*Thecodiplosis,* Cecidomyiini	leaf (needle)	*Pinus,* Coniferae
mayetiolae Kieffer, 1916	*Mayetiola,* Oligotrophini	stem swelling	*Dactylis,* Graminaceae
mediocris (Brues, 1910)	*Bruggmannia,* Asphondyliini	leaf gall	*Myrsine,* Myrsinaceae
mediocris (Brues, 1910)			*Psychotria,* Rubiaceae
minutula Dalla Torre, 1898	*Mayetiola,* Oligotrophini	stem without gall	*Triticum,* Graminaceae
nigra Nees, 1834	*Wachtliella,* Oligotrophini	leaf margin rolls	*Polygonum,* Polygonaceae
nigra Nees, 1834	*Dasineura,* Oligotrophini	leaf gall	*Filipendula,* Rosaceae
nigricoxa Fouts, 1925	*Dasineura,* Oligotrophini	stem gall	*Lupina,* Fabaceae
nigripes Ratzeburg, 1852	*Dasineura,* Oligotrophini	gall	*Abies,* Coniferae
nitida Thomson, 1859	*Dasineura,* Oligotrophini	siliqua swelling	*Brassica,* Cruciferae
nodicola (Kieffer, 1916)	*Dasineura,* Oligotrophini	stem swelling	*Salix,* Salicaceae
obscura Nees, 1834	*Lasioptera,* Lasiopterini	stem swelling	*Rubus,* Rosaceae
obscuripennis Ashmead, 1893	*Mayetiola,* Oligotrophini	stem gall	*Salix,* Salicaceae
oebalus Walker, 1835	*Dasineura,* Oligotrophini	siliqua swelling	*Brassica,* Cruciferae
oleae Szelényi, 1940	*Dasineura,* Oligotrophini	leaf gall	*Olea,* Oleaceae
ornatus Kieffer, 1906	*Dasineura,* Oligotrophini	leaf margin rolls	*Pyrus,* Rosaceae
ornatus Kieffer, 1906	*Dasineura,* Oligotrophini	leaf gall	*Spiraea,* Rosaceae
oryzae Cameron, 1891	*Orseolia,* Cecidomyiini	stem gall	*Oryza,* Graminaceae

pauliani Risbec, 1953		gall	*Vernonia*, Compositae
pauliani Risbec, 1953		gall	*Macaranga*, Euphorbiaceae
persicariae Kieffer, 1906	*Wachtliella*, Oligotrophini	leaf margin rolls	*Polygonum*, Polygonaceae
philinna Walker, 1835	*Dasineura*, Oligotrophini	stem without gall	*Salix*, Salicaceae
philippiae Risbec, 1953		flower gall	*Philippia*, Ericaceae
phragmitis (Schrank, 1781)	*Lasioptera*, Lasiopterini	swollen shoots	*Phragmites*, Graminaceae
piniphila MacGown, 1979			*Pinus*, Coniferae
pinyonicola MacGown, 1979	*Pinyonia*, Cecidomyiini	leaf (needle) gall	*Pinus*, Coniferae
pleuron Walker, 1835	*Mayetiola*, Oligotrophini	stem without gall	*Triticum*, Graminaceae
ponderosae MacGown, 1979	*Contarinia*, Cecidomyiini	leaf (needle) gall	*Pinus*, Coniferae
producta MacGown, 1979	*Contarinia*, Cecidomyiini	leaf (needle) gall	*Pinus*, Coniferae
prolata MacGown, 1971		under bark	*Pinus*, Coniferae
pseudotsugae MacGown, 1979		cone	*Pseudotsuga*, Coniferae
ramachandrai (Rao, 1950)		gall	*Andropogon*, Graminaceae
relativa Fouts, 1924		gall	*Aster*, Compositae
resinosae MacGown, 1979			*Pinus*, Coniferae
rhabdophagae MacGown, 1979	*Dasineura*, Oligotrophini	bud gall	*Picea*, Coniferae
riparia Yamagishi, 1980	*Dasineura*, Oligotrophini	bud gall	*Salix*, Salicaceae
rohweri Fouts, 1924		cone	*Pinus*, Coniferae
rubi (Ashmead, 1893)	*Lasioptera*, Lasiopterini	stem swelling	*Rubus*, Rosaceae
sagana Walker, 1835	*Rhopalomyia*, Oligotrophini2)	flower swelling	*Achillea*, Compositae
salicicola (Ashmead, 1893)		leaf gall	*Salix*, Salicaceae
saliciperdae Kieffer, 1913	*Dasineura*, Oligotrophini	stem without gall	*Salix*, Salicaceae
salvadorae Rao, 1950	*Resseliella*, Cecidomyiini	stem gall	*Salvadora*, Fabaceae
sambuci (Kieffer, 1916)	*Arnoldiola*, Oligotrophini	flower swelling	*Sambucus*, Caprifoliaceae
scrophulariae (Kieffer, 1916)	*Contarinia*, Cecidomyiini	flower swelling	*Scrophularia*, Scrophulariaceae
semiglabra (Girault, 1920)	*Rhopalomyia*, Oligotrophini	gall	*Vernonia*, Compositae
shastensis Fouts, 1924		cone	*Abies*, Coniferae
similis MacGown, 1974		stem gall	*Chrysothamnus*, Compositae
sociabilis Kieffer, 1910	*Xenodiplosis*, Cecidomyiini	bud gall	*Geoffraea*, Fabaceae
solidaginis (Ashmead, 1887)	*Asteromyia*, Alycaulini	leaf gall	*Solidago*, Compositae
solidaginis (Ashmead, 1887)	*Cecidomyia*, Cecidomyiini	gall	*Solidago*, Compositae
solidaginis (Ashmead, 1887)		stem gall	*Aster*, Compositae
splendidula Ruthe, 1859	*Mayetiola*, Oligotrophini	stem (culm) gall	*Poa*, Graminaceae
stachydis (Kieffer, 1916)	*Ametrodiplosis*, Cecidomyiini	flower swelling	*Stachys*, Labiatae
stefaniellae Buhl, 2000	*Stefaniella*, Lasiopterini	stem gall	*Atriplex*, Chenopodiaceae
stefaniolae Buhl, 1998	*Stefaniola*, Lasiopterini	gall	*Salsola*, Chenopodiaceae
stimulator Yamagishi, 1980	*Dasineura*, Oligotrophini	bud gall	*Salix*, Salicaceae
striaticeps (Ashmead, 1893)	*Aspidiotus*	gall	*Artemisia*, Compositae
striaticeps (Ashmead, 1893)			*Bigelovia*, Compositae
subterraneus (Kieffer, 1916)	*Dasineura*, Oligotrophini	bud gall	*Galeobdolon*, Labiatae
subterraneus (Kieffer, 1916)	*Lasioptera*, Lasiopterini	stem swelling	*Rubus*, Rosaceae
suecicus (Kieffer, 1926)	*Lasioptera*, Lasiopterini	stem swelling	*Foeniculum*, Umbelliferae
sugitama			
Yoshida & Hirashima, 1979	*Contarinia*, Cecidomyiini	leaf	*Cryptomeria*, Taxodiaceae
szelenyii Huggert, 1975	*Giraudiella*, Oligotrophini	stem gall	*Phragmites*, Graminaceae
taras Walker, 1835	*Haplodiplosis*, Cecidomyiini	stem depressions	*Triticum*, Graminaceae
taylori MacGown, 1974	*Lasioptera*, Lasiopterini	stem gall	*Rubus*, Rosaceae
tibialis Kieffer, 1905	*Lasioptera*, Lasiopterini	gall	*Polygonum*, Polygonaceae
transsylvanicus (Szelényi, 1958)	*Dasineura*, Oligotrophini	gall	*Sisymbrium*, Cruciferae
tuberculi (Kieffer, 1916)	*Dasineura*, Oligotrophini	stem swelling	*Sarothamnus*, Fabaceae
tuberosula Kieffer, 1926	*Contarinia*, Cecidomyiini	flower without swelling	*Triticum*, Graminaceae
tuberosula Kieffer, 1926	*Sitodiplosis*, Cecidomyiini	flower swelling	*Triticum*, Graminaceae
tubulosa Brues, 1922	*Ledomyia*, Ledomyiini	under bark	*Quercus*, Fagaceae
tubulosa Brues, 1922	*Janetiella*, Oligotrophini	under bark	*Fraxinus*, Oleaceae
tumida (Ashmead, 1893)	*Cincticornia*, Asphondyliini	leaf gall	*Quercus*, Fagaceae
tumoricola Kieffer, 1910	*Meunieriella*, Camptoneuromyiini	stem swelling	*Baccharis*, Compositae
ulmicola Kieffer, 1916	*Janetiella*, Oligotrophini	leaf gall	*Ulmus*, Ulmaceae
umbraculi (Kieffer, 1916)	*Paralleldiplosis*, Cecidomyiini	leaf gall (of cynipid)	*Quercus*, Fagaceae
urnicola Yamagishi, 1980	*Dasineura*, Oligotrophini	stem gall	*Salix*, Salicaceae
utahensis (Ashmead, 1893)		gall	*Artemisia*, Compositae
vaenia Walker, 1835	*Procystiphora*, Oligotrophini	stem	*Juncus*, Juncaceae
variabilis Fouts, 1924	*Rhopalomyia*, Oligotrophini	fruit swelling	*Solidago*, Compositae
verdii Vlug, 1995	*Thecodiplosis*, Cecidomyiini	leaf (needle fascicle) gall	*Pinus*, Coniferae
vernalis (Myers, 1917)	*Mayetiola*, Oligotrophini	stem without gall	*Triticum*, Graminaceae
vernoniae (Ashmead, 1893)		gall	*Vernonia*, Compositae
verrucosa Kieffer, 1916	*Anabremia*, Cecidomyiini	leaf gall	*Lathyrus*, Fabaceae
viburni Kieffer, 1916	*Contarinia*, Cecidomyiini	flower swelling	*Viburnum*, Caprifoliaceae
victoriae MacGown, 1979		hyperparasite?	*Pinus*, Coniferae
virginiensis (Ashmead, 1893)	*Thecodiplosis*, Cecidomyiini	stem gall	*Taxodium*, Cupressaceae
virgo Day, 1971	*Giraudiella*, Oligotrophini	stem gall	*Phragmites*, Graminaceae
viticola (Ashmead, 1893)	*Lasioptera*, Lasiopterini	stem gall	*Vitis*, Vitaceae
zangherii Szelényi, 1955	*Apiomyia*, Oligotrophini	stem gall	*Pyrus*, Rosaceae
zaragozana Buhl, 1998	*Etsuhoa*, Cecidomyiini	terminal bud gall	*Juniperus*, Coniferae
zosine Walker, 1835	*Mayetiola*, Oligotrophini	stem swelling	*Avena*, Graminaceae
zosine Walker, 1835	*Mayetiola*, Oligotrophini	stem without gall	*Triticum*, Graminaceae

different plant families but both from non-cecidomyiid galls (inquiline hosts?). *P. tubulosa* is an extralimital species (subgenus *Cylindrogaster* Huggert, 1980), cf. also Austin & Field (1997).

- Graminaceae: The following grouping could tentatively be suggested: 1) *P. virgo, taras,* and *pleuron*; 2) *P. attenuata* and *phragmitis*; 3) *P. gyrone, hiemalis, leptocera, mayetiolae, splendidula,* and *szelenyii. P. attenuata* attacks midges belonging to different tribes on grasses. On the other hand, it is hard to find any parallel associations for the similar species *hiemalis, burkei,* and *eurotiae.*
- Juncaceae: *P. vaenia* is a very aberrant species, and also the only species of the genus known from this plant family (and from the host midge genus).
- Labiatae: *P. subterraneus* and *stachydis* share many key characters as well as association with plant family (midge association less indicative). *P. coloradensis,* on the other hand, is a rare example that midge association is more indicative for close relative (*P. californica*) than plant family association.
- Rosaceae: Though split between two midge tribes the following species seem rather close: *P. apicalis, demades, marchali, ornatus, rubi,* and *subterraneus* (which fits equally well with *stachydis*).
- Salicaceae: Among the wasps associated with this family some three species-groups can possibly be discerned: 1) *P. asynaptae* and *salicicola* (and perhaps *euurae*); 2) *P. iteophilus* and *athamas* (and perhaps *brevistriata*); 3) *P. longestriata, riparia, urnicola,* and *iteocrypta* (from the description in Kieffer (1926) *brevistriata* could also fit in this group). *P. athamas,* on the other hand, is a rare documented case (by Vlug (1985)) of a species which is associated with three plant families (but only one midge tribe).
- Solanaceae: *P. lyciicola* seems to be another example of the importance of plant association overruling midge association.
- Umbelliferae: The similar *P. cottei* and *eryngii* share midge genus as well as plant family association.

That the species of "genus" *Prosactogaster* Kieffer, 1914 (characterised only by long metasoma with anteriorly prolonged 2nd sternite accommodating the extra long ovipositor) are hardly closely related to each other is perhaps supported by their widely different midge and plant associations. The biology of six species is mentioned in Vlug (1995), who treated *Prosactogaster* as a separate genus. The present author regards them as an arbitrary selection of species from a number of *Platygaster* species groups, having convergently developed long ovipositor as a response to interspecific competition for midge hosts living well-protected or relatively deep below the plant surface.

Discussion

Though most of the gall midges in the holarctic region attack Compositae (followed by Salicaceae and Graminaceae according to Richards & Davies (1988)), most *Platygaster* with known biology are associated with Coniferae, closely followed by Graminaceae – only as number three, rather far behind, Compositae (mostly Neotropical). Thus, the pattern mentioned by Memmott & Godfray (1993) that greater parasitoid loads are to be found on hosts on trees and shrubs in comparison with hosts on low-growing plants (explained by an assumed greater difficulty of locating hosts on early successional plants dispersed throughout a habitat) does hardly seem to apply for *Platygaster*; however, with view to their hosts' preference for Compositae the wasp preference for conifers is more significant than its purely numerical value compared to wasps on low-growing plants suggests at first glance.

Spatial distribution, plant architecture and -ultrastructure, typical forms of galls associated with each plant family, microclimate (in e.g. lower vegetation or tree tops), plant/

host chemistry, and history of the geographical distribution of the plants are among the many factors which could concentrate a platygastrid group on certain plant groups, the behavioral and ecological aspects being at least as important in evolution as wasp morphology. Altieri et al. (1993) mention a number of studies showing that several chemical, genetic and architectural attributes of plants can influence parasitoid action on insect hosts (cf. also Quicke (1997: 307)). E.g., it is hardly without evolutionary significance that alkaloids and other allelochemicals involved in plant resistance can be toxic to parasitoids within hosts – perhaps part of an explanation of also the plant associations of *Platygaster* species groups (but as in everything concerning parasitoid wasp biology only studied for very few (non-platygastrid) species). Also, many parasitoids seek out particular habitats and are guided by volatiles emanating from plants. "There is thus no doubt that the plant has a huge influence on the evolution and behavioral ecology of host-parasitoid interactions." (Godfray 1994: 353). An understanding of these tri-trophic interactions is not just of theoretical interest. As noted by Sands (2000) it may also be very important when selecting parasitoids for biological control programs.

Probably the development of the species-groups forming the "*Platygaster*-cluster" has been very complex, with several invasions of midges on a plant family by different species-groups taking place, may be following the midge host in co-evolution, leaving their close relatives in the old host plant association, making it today nearly always very difficult to say what is the advanced condition due to the limited information in platygastrid morphology. However, Quicke (1997: 344) remarks that co-cladogenesis appears to be of minor importance in parasitic Hymenoptera, and this also seems to be confirmed by the data in table 1. But it also indicate that many exceptions from simple generalisations could exist. However, even if a species is sometimes reared from another plant family than expected, this says nothing about that it may very possible perform less well than usual on certain hosts due to their host plant (Sands, 2000).

MacGown (1979: 17) for the species-groups considered by him supposed two separate invasions from conifers to non-conifers – or two separate invasions of the conifers by the respective groups. The relatively large diversity of *Platygaster* on Graminacae and Coniferae are no doubt to some degree a reflection on the level of investigation but probably also indicates the relative abundance of this taxonomic assemblage of platygastrids in boreal and subtropical biotopes where life-conditions (e.g. host abundance and distinct seasons) make life in some ways easier for small parasitoids than in the tropics, cf. Godfray (1994: 357).

If the evolution of *Platygaster* species takes place through transference between similar types of galls induced by different midge species, then midge phylogeny is not a reliable guide to wasp taxonomy as a correlation between the taxonomic position of gall midges and the form of their galls is doubtful (Roskam, 1992). E.g., the similar species *P. subterraneus* and *stachydis* attack three species of midges which all create swollen deformations on Fabaceae (necessitating the elongated gaster – with long ovipositor – of the parasitoids). Further, *P. attenuata* and *phragmitis* attack distinctly related midges living under identical circumstances, i.e. under gall-like depressions or constrictions in cereal crops and *Phragmites*, respectively (Rübsaamen & Hedicke, 1925-39). (The long metasoma of the parasitoids seems to be necessary here because the midge larva live in the stem beneath the sheath, cf. Barnes (1956)). Without pressing the evidence too far, there are also indications of a similar biology for the hosts of *P. gyrone, hiemalis, leptocera, mayetiolae*, and *szelenyii*, the midges living at the surface of the plant at least when hatching (Barnes, 1956; Rübsaamen & Hedicke, 1925-39), making a long parasitoid metasoma (and ovipositor) not necessary. *P. apicalis, demades, marchali, ornatus, rubi*, and *subterraneus* all seem to parasitise midges in swollen plant deformations, *P. demades* also in rolled leaf edges (descriptions of host galls in Rübsaamen & Hedicke (1925-39)). It must be

logical, however, that certain midges can be attacked only by parasitoids with a long enough ovipositor – but these parasitoids also have the chance to switch to host nearer the plant surface. The opposite option naturally does not exsist for *Platygaster* species with short metasoma (the length of the female metasoma rather accurately reflects the length of the ovipositor). The possibility of a single *Platygaster* species having different metasomal length according to the relevant host on a specific locality is indicated by Huggert (1974), illustrating the range of morphological variation in *P. depressiventris* Thomson, 1859. (Such intraspecifc variation seems to be widespread in *Platygaster*, possibly facilitating sympatric speciation when a population has adapted to a specific host? Cf. Godfray (1994: 355)) A similar phenomenon was proposed by Gibbons (1979) concerning an ichneumonid genus where ovipositor length provided a means of dividing a single host resource, caused by a sympatric speciation mechanism (competitive speciation).

Of the parasitoids of Salicaceae *P. iteophilus* and *athamas* both seem to live on midges in the terminal buds on *Salix*; *P. longestriata* and *iteocrypta* parasitise in stem galls, *longestriata* also in galls on leaves – perhaps a transition to *brevistriata* which only is known to parasitise galls on leaves. *P. philinna* occurs in 3 midge species, all in *Salix* stems without galls. (Information on host relations as almost always from Vlug (1995), on host biology from Kieffer (1926) and Barnes (1951)).

A reason why *Platygaster* species are less associated with taxonomic entitites of midges than with entities of plants or possibly gall types could be the capability of many midge species to form very different kinds of galls on different parts of the plant, as well as the host range of some midge species which cover up to five plant families (Barnes, 1953). Rather than following its host midges to different plant families (and to different parts of the plant?) a parasitoid would more naturally select other midge species on the same plant, due to the earlier mentioned important role plants play in the host selection process by providing cues to the location of a potential host community, cf. also Vinson (1984) who notes that parasitoids have evolved to respond to cues not only produced by the host, but also cues provided by the food and shelter of the host and associated organisms. A possible cue is a specific type of gall; *Platygaster* species have to my knowledge not at present been reared from different gall types induced by the same midge species, but this could be due solely to lack of investigation.

It is hard to compare on a statistical basis the host plant association of the genera most closely related to *Platygaster*, (the "*Platygaster*-cluster" sensu Austin & Field (1997)), e.g. *Trichacis* Foerster, 1856 and *Isocybus* Foerster, 1856, as these genera are much less rich in known species and furthermore with poorly known biology. Of the seven species of *Trichacis* with known biology, 3 are associated with Graminaceae, and 1 with a plant of each of the following families: Cornaceae, Solanaceae, Malvaceae, and Fagaceae. Of the two species of *Isocybus* with known biology, 1 is associated with a midge on *Brassica* (Cruceferae), 1 with *Carex* (Graminaceae) (Vlug, 1995).

Quite a different picture appears when looking at the slightly more distant "*Synopeas*-cluster" sensu Austin & Field (1997), dominated by the very large genus *Synopeas* Foerster, 1856. The about forty species with host associations noted mostly by Vlug (1995) attack midges on the following plant families: 10 species on Salicaceae, 4 species on Fabaceae, 3 species on Fagaceae, 3 on Anacardiaceae, 3 on Coniferae, 2 on Chenopodiaceae, 2 on Cruciferae, and 1 *Synopeas* species on each of the following: Aquifoliaceae, Ribesiaceae, Umbelliferae, Myrtaceae, Compositae, Bignoniaceae, Urticaceae, Malvaceae, and Rosaceae. In other words, a remarkable diversity of associations with a very different priority than in *Platygaster*, with Salicaceae being far on the top on the hit list for *Synopeas*, only number four for *Platygaster*. Furthermore, the most popular plants for *Platygaster* are almost (Coniferae and Compositae) or entirely (Graminaceae) absent as

plant association for *Synopeas*. The midges hosts for *Synopeas* are almost equally distributed in Cecidomyiini and Oligotrophini with very few known hosts belonging to other tribes; in *Platygaster* more than twice as many species have hosts in Oligotrophini as in Cecidomyiini.

In conclusion, in morphology as well as in biology there seems to be a deep split between "*Synopeas*" and "*Platygaster*", diversifying a long time ago on their hosts in quite different ways. Inside *Platygaster* s.l. a large number of groups distinct on account of morphology as well as biology are evidently present, but with regard to their interrelatedness and historical development it is at the present level of study only possible to quote Nicolaus Steno's famous dictum: "Pulchra sunt, quae videntur, pulchriora quae sciutur, longe pulcherrima quae ignorantur". ("Beautiful is what we see; more beautiful is what we understand, but by far the most beautiful is what our mind can not contain"). The present synopsis is mostly conjectural and points only to a few tendencies to which future research is recommended to pay attention. But at least it seems to confirm the rule mentioned by Vinson (1984) that there is less tendency for parasitoids to select phylogenetically related hosts than unrelated hosts found on the same plant. It is mentioned by the same source that the widespread evidence of the importance of plants in parasitoid's host location perhaps point to the evolution of the parasitoid habitat in Hymenoptera which may have stemmed from a previous plant-parasite relationship.

Acknowledgements

I thank Dr. Raymond J. Gagné (Systematic Entomology Laboratory, Beltsville) for information on the biology and taxonomy of some midge species.

Dansk sammendrag

En undersøgelse af snyltehvepseslægten *Platygaster* for så vidt angår dens mange arters relationer til deres galmyg-værter og disses værtsplanter synes at vise eksistensen af et antal naturlige hvepse-artsgrupper, som er begrænset til galmygværter på bestemte plantefamilier. Galmyggenes slægtskabsforhold synes at have mindre betydning for hvepsenes biologi, men en del undtagelser fra denne regel forekommer. De mulige årsager til disse forhold diskuteres i artiklen, som bringer en opdateret komplet oversigt over kendte *Platygaster*-værts-/værtsplanteforhold. Det vises desuden, at de *Platygaster*-arter, hvis værter kendes, generelt foretrækker myg på plantefamilier i et forhold, der ikke er repræsentativt for den generelle fordeling af galmygarter på plantefamilier. Endelig viser en sammenligning mellem værtsvalget for *Platygaster*-slægtsgruppen og for *Synopeas*-slægtsgruppen store forskelle hvad angår både fordelingen på galmygværter og på plantefamilier.

References

Altieri, M.A., J.R. Cure & M.A. Garcia, 1993. The role and enhancement of parasitic Hymenoptera biodiversity in agroecosystems (pp. 257-275). In: J. LaSalle & I.D. Gauld (eds.): *Hymenoptera and biodiversity*. CAB International, Wallingford. 348 pp.

Austin, A.D. & S.A. Field, 1997. The ovipositor system of scelionid and platygastrid wasps (Hymenoptera: Platygastroidea): comparative morphology and phylogenetic implications. – *Invertebrate taxonomy* 11: 1-87.

Barnes, H.F., 1951. *Gall midges of economic importance. Vol. V: Gall midges of trees.* Crosby Lockwood & Son, Ltd., London. 270 pp.

Barnes, H.F., 1953. The biological approach to the species problem in gall midges (Dipt., Cecidomyidae). – *Annales entomologici fennici* 19: 2-24.

Barnes, H.F., 1956. *Gall midges of economic importance. Vol. VII: Gall midges of cereal crops.* Crosby Lockwood & Son, Ltd., London. 261 pp.
Fouts, R.M., 1924. Revision of the North American wasps of the subfamily Platygasterinae. – *Proceedings of the United States National Museum* 63(15a): 1- 145.
Gagné, R.J., 1994. *The gall midges of the neotropical region.* Cornell University Press, Ithaca and London. 352 pp.
Gibbons, J.R.H., 1979. A model for sympatric speciation in *Megarhyssa* (Hymenoptera: Ichneumonidae): competitive speciation. – *American Naturalist* 114: 719-741.
Godfray, H.C.J., 1994. *Parasitoids: Behavioral and Evolutionary Ecology.* Princeton University Press, Princeton. 473 pp.
Griffiths, G.C.D., 1964. The Alysiinae (Hym. Braconidae) parasites of the Agromyzidae (Diptera). I. General questions of taxonomy, biology and evolution. - *Beiträge zur Entomologie* 14: 823-914.
Griffiths, G.C.D., 1966. The Alysiinae (Hym. Braconidae) parasites of the Agromyzidae (Diptera). II. The parasites of *Agromyza* Fallén. - *Beiträge zur Entomologie* 16: 551-605.
Griffiths, G.C.D., 1966. The Alysiinae (Hym. Braconidae) parasites of the Agromyzidae (Diptera). III. The parasites of *Paraphytomyza* Enderlein, *Phytagromyza* Hendel and *Phytomyza* Fallén. – *Beiträge zur Entomologie* 16: 775-951.
Huggert, L., 1974. Taxonomical studies on the species belonging to *Urocyclops* Maneval (Hym. Proctotrupoidea, Platygastrinae). – *Entomologisk Tidskrift* 95: 58-63.
Kieffer, J.J. 1926. *Scelionidae.* In: Das Tierreich 48. Walter de Gruyter & Co., Berlin. 885 pp.
MacGown, M.W., 1974. New nearctic *Platygaster* (Hymenoptera: Proctotrupoidea, Platygastridae): The *coloradensis* group. – *Canadian Entomologist* 106: 213-219.
MacGown, M.W., 1979. The Platygastridae (Hymenoptera: Proctotrupoidea) parasitic on midges (Cecidomyiidae) found on conifers in Canada and the United States. – *Information Bulletin* 9, Mississippi Agricultural & Forestry Experiment Station. 144 pp.
Memmott, J. & H.C.J. Godfray, 1993. Parasitoid webs (pp. 217-234). In: J. LaSalle & I.D. Gauld (eds.): *Hymenoptera and biodiversity.* CAB International, Wallingford. 348 pp.
Quicke, D.L.J., 1997. *Parasitic wasps.* Chapman & Hall, London. 470 pp.
Richards, O.W. & R.G. Davies, 1988. *Imms' general textbook of entomology.* Tenth Edition (1977, 2nd reprint 1988). Volume 2 (pp. 421-1354). Chapman and Hall, London.
Roskam, J.C., 1986. Biosystematics of insects living in female birch catkins. IV. Egg-larval parasitoids of the genera *Platygaster* Latreille and *Metaclisis* Förster (Hymenoptera, Platygastridae). – *Tijdschrift voor Entomologie* 129: 125-140.
Roskam, J.C., 1992. Evolution of the gall-inducing guild (pp. 34-49). In: J.D. Shorthouse & O. Rohfritsch (eds.): *Biology of insect-induced galls.* Oxford University Press, Oxford. 285 pp.
Rübsaamen, E.H. & H. Hedicke, 1925-1939. *Die Zoocecidien, durch Tiere erzeugte Pflanzengallen Deutschlands und ihre Bewohner.* II. Band. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart. 350 pp., with 42 coloured plates.
Sands, D.P.A., 2000. Taxonomic relationships of parasitoids: poor indicators for their suitability or effectiveness as biological control agents (pp. 410-416). In: A.D. Austin & M. Dowton (eds.): *Hymenoptera: evolution, biodiversity and biological control.* CSIRO Publishing, Collingwood. 468 pp.
Skuhravá, M., 1986. Family Cecidomyiidae (pp. 72-297). In: A. Soós (ed.): *Catalogue of Palaearctic Diptera. 4. Sciaridae-Anisopodidae.* Akademiae Kiado, Budapest. 441 pp.
Vinson, S.B., 1984. Parasitoid-host relationship (pp. 205-233). In: W.J. Bell & R.T. Cardé (eds.): *Chemical ecology of insects.* Chapman and Hall, London. 524 pp.
Vlug, H.J., 1985. The types of Platygastridae (Hymenoptera, Scelionoidea) described by Haliday and Walker and preserved in the National Museum of Ireland and in the British Museum (Natural History). 2. Keys to species, redescriptions, synonymy. – *Tijdschrift voor Entomologie* 127: 179-224.
Vlug, H.J., 1995. Catalogue of the Platygastridae (Platygastroidea) of the world. – *Hymenopterorum Catalogus.* Pars 19: 1-168.