

# New Sex Attractant for *Jordanita anatolica* (Naufock) (Lepidoptera: Zygaenidae: Procridinae)

Konstantin A. Efetov<sup>1</sup>, Feza Can<sup>2</sup>, Teodora B. Toshova<sup>3</sup>, Mitko Subchev<sup>3</sup>

<sup>1</sup> Crimean State Medical University, UA-95006 Simferopol, Crimea, Ukraine; E-mail: konst@efetov.crimea.ua

<sup>2</sup> University of Mustafa Kemal, Faculty of Agriculture, Department of Plant Protection, 31034 Hatay, Turkey;  
E-mail: fezacan@mku.edu.tr

<sup>3</sup> Bulgarian Academy of Sciences, Institute of Zoology, 1 Tzar Osvoboditel, Blvd. 1000 Sofia, Bulgaria;  
E-mails: subchev@zoology.bas.bg, toshova@zoology.bas.bg

**Abstract:** Four compounds, (2*R*)-butyl (7*Z*)-dodecenoate, (2*R*)-butyl (9*Z*)-tetradecenoate, (2*S*)-butyl (7*Z*)-dodecenoate and (2*S*)-butyl (9*Z*)-tetradecenoate, and mixtures of them were screened in sticky delta traps at two places, Serinyol and Yayladađı, in South East Turkey. As a result numerous *Jordanita anatolica* (NAUFOCK) (Lepidoptera: Zygaenidae: Procridinae) males were caught mainly in traps baited with the 1:1 mixture of (2*R*)-butyl (7*Z*)-dodecenoate and (2*S*)-butyl (7*Z*)-dodecenoate. This is the first report on a sex attractant for *J. anatolica*. Both start and end of the flight of this species have not been exactly determined during the field work but from the results obtained it could be concluded that this species started flying before the middle of May and the season stopped after July 1. Two more species were caught during the field work. One male of *Adscita obscura* (ZELLER) was found in a trap baited with (2*S*)-butyl (7*Z*)-dodecenoate at Serinyol and another one in a trap baited with (2*R*)-butyl (7*Z*)-dodecenoate + (2*S*)-butyl (7*Z*)-dodecenoate at Yayladađı. A total of 16 *Theresimima ampellophaga* (BAYLE-BARELLE) males were caught in traps baited with (2*S*)-butyl (7*Z*)-tetradecenoate, additionally screened compound, at both sites of screening.

**Key words:** Zygaenidae, Procridinae, *Jordanita anatolica*, sex attractant, (2*R*)-butyl (7*Z*)-dodecenoate, (2*S*)-butyl (7*Z*)-dodecenoate

## Introduction

The members of the subfamily Procridinae (Lepidoptera: Zygaenidae) developed sex pheromone systems – pheromone glands, female calling posture and chemistry of the sex pheromones – that are significantly different from other Lepidoptera and even from the sex pheromone system of the other zygaenids (SUBCHEV 2003). Females of all Procridinae species investigated so far (EFETOV 2001, TOSHOVA, SUBCHEV 2005) have a typical calling posture described for the first time in *Theresimima ampellophaga* by SUBCHEV, HARIZANOV (1990) which corre-

sponds with the specific location of the pheromone gland in females of this subfamily – on the dorsal part of the abdomen described in the same species by HALLBERG, SUBCHEV (1997). The first sex pheromone compound identified for this subfamily was 2-butyl (7*Z*)-tetradecenoate found in the females of *Harrisina brillians* BARNES & McDUNNOUGH (synonym of *H. metallica* STRETCH) with (*S*)-enantiomer proved to be active as an attractant for the conspecific males in field (MYERSON *et al.* 1982). Later the (*R*)-enantiomer of the same compound was found in

the pheromone glands of *T. ampellophaga* (SUBCHEV *et al.* 1998). Two other esters of fatty acids, 2-butyl (7Z)-dodecenoate and 2-butyl (9Z)-tetradecenoate were identified in a third member of the subfamily Procridae – *Illiberis rotundata* JORDAN, and both (R)- and (S)-enantiomers of each compound were synthesized (SUBCHEV *et al.* 2009).

In the present paper we report on the result of a screening of (2R)-butyl (7Z)-dodecenoate (R-7-12), (2R)-butyl (9Z)-tetradecenoate (R-9-14), (2S)-butyl (7Z)-dodecenoate (S-7-12) and (2S)-butyl (9Z)-tetradecenoate (S-9-14) and mixtures of them at two places in South East Turkey. In this screening (2S)-butyl (7Z)-tetradecenoate (S-7-14), a minor sex pheromone component of *T. ampellophaga* (SUBCHEV *et al.* 1998, erratum), was also included.

## Materials and Methods

The syntheses of R-7-12, R-9-14, S-7-12 and S-9-14 are described in SUBCHEV *et al.* (2009) and the synthesis of S-7-14 in SUBCHEV *et al.* (1998). The enantiomeric purity of these compounds was: 98.5% for R-7-12 and R-9-14, 92% for S-7-12, 95% for S-9-14 and 98% for S-7-14.

Pheromone baits were prepared by applying solutions of the test compound or mixture of compounds in n-hexane (Merck, GC grade) onto rubber caps in doses of 100 µg. Besides the single compounds the following mixtures in a ratio of 1:1 were tested: R-7-12 + S-7-12, R-7-12 + R-9-14, S-7-12 + S-9-14 and R-9-14 + S-9-14.

Field tests were organized at two places in South East Turkey: Serinyol and Yayladağı, located at about 60 km apart from each other. Delta traps with sticky layers covered with Tanglefoot® insect glue were used in the field tests. Two replicates of the tested set of baits were screened in each place. The distance between the replicates was about 6 km in Serinyol (110 and 171 m altitude respectively) and 15 km in Yayladağı (483 and 900 m altitude respectively). The pheromone baits were installed in the field on May 12, 2009 in Yayladağı and May 15, 2009 in Serinyol. The traps were checked at 1-2 week interval up to July 1, 2009.

Trap catch data were transformed (square root  $[x+0.5]$ ) prior to the analysis. The transformed data were subjected to a two-way ANOVA (GLM proce-

dure), with bait and place as independent variables. Subsequently, within each site, LSD test was performed for multiple comparisons of catches in traps with different baits. Statistical analyses were performed using SPSS 11.0.1. (SPSS Inc., 2001). The significant difference was set at  $P < 0.05$ .

## Results

At the two places, Serinyol and Yayladağı, numerous catches of *Jordanita (Praviela) anatolica* (Naufock) were recorded.

A two-way ANOVA analysis showed strong differences in catches in traps with the eight baits tested ( $F = 25.002$ ,  $df = 7$ ,  $P < 0.001$ ). At both sites, Serinyol and Yayladağı, mean catches in traps baited with a mixture of R-7-12 and S-7-12 were significantly higher than those in traps with the rest baits tested (ANOVA followed by LSD test,  $P < 0.05$ ). No significant difference among the catches in the traps with the rest baits tested was found although at both sites the catches in the traps baited with R-7-12 only were highest (Table 1). The place had no significant influence on trap catches ( $F = 0.930$ ,  $df = 1$ ,  $P = 0.336$ ). There was no significant interaction between bait and site also ( $F = 0.204$ ,  $df = 1$ ,  $P = 0.984$ ).

Both start and end of the flight of *J. anatolica* have not been exactly determined during our field work. However, from the results obtained we could conclude that this species started flying before the middle of May and the season stopped after July 1 (Fig. 1).

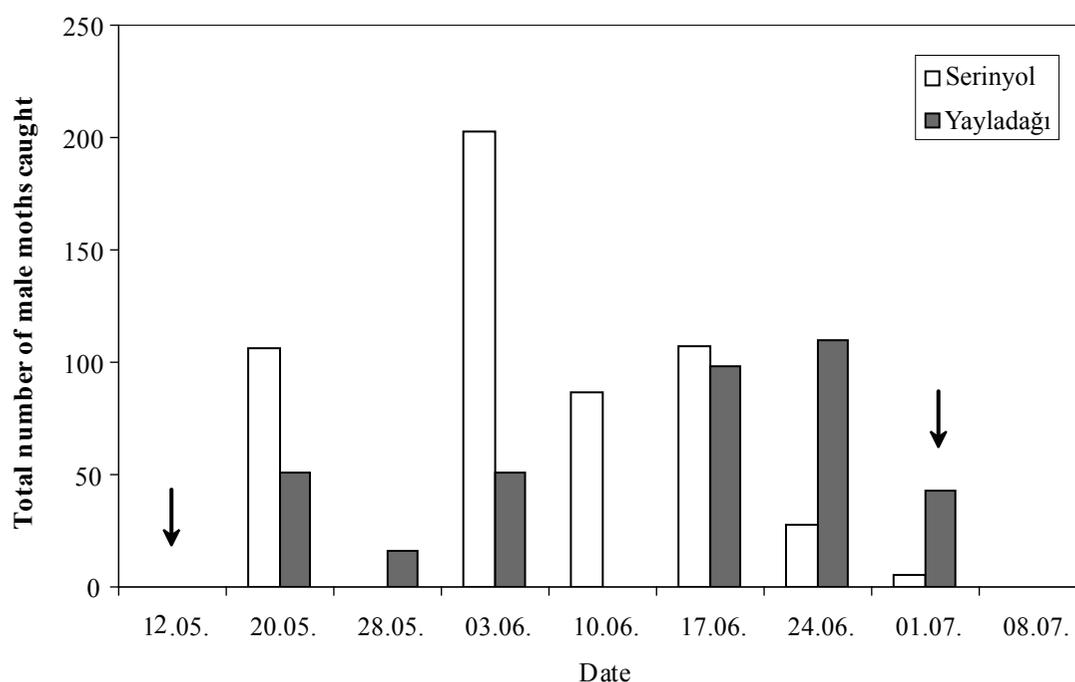
Two more species were caught during our field work. One male of *Adscita (Adscita) obscura* (ZELLER) was found in a trap baited with S-7-12 at Serinyol and another one in a trap baited with R-7-12 + S-7-12 at Yayladağı. A total of 16 *Theresimima ampellophaga* (BAYLE-BARELLE) males were caught in traps baited with S-7-14 at both sites of screening.

## Discussion

This is the first report on a sex attractant for *J. anatolica*. The large number of male moths of this species caught in traps baited with the 1:1 mixture of R-7-12 and S-7-12 in our recent study strongly indicated that this mixture, or a very close combination, could comprise the components of the natural sex

**Table 1.** Catches of *J. anatolica* male moths in traps baited with single compounds or their mixtures, Turkey, 20 May – 1 July, 2009, two replicates at each place. Mean catches marked with different letters in a column are significantly different by ANOVA followed by LSD test ( $P < 0.05$ ).

Compound, $\mu\text{g}$				Place			
				Serinyol		Yayladağı	
R-7-12	S-7-12	R-9-14	S-9-14	Total number caught	Mean catches trap/inspection ( $\pm$ SE)	Total number caught	Mean catches trap/inspection ( $\pm$ SE)
100				96	6.86b ( $\pm$ 4.56)	21	1.50b ( $\pm$ 1.28)
	100			1	0.07b ( $\pm$ 0.07)		0.00b ( $\pm$ 0.00)
		100			0.00b ( $\pm$ 0.00)		0.00b ( $\pm$ 0.00)
			100		0.00b ( $\pm$ 0.00)		0.00b ( $\pm$ 0.00)
100	100			398	28.43a ( $\pm$ 8.18)	343	24.50a ( $\pm$ 7.02)
100		100		20	1.43b ( $\pm$ 0.95)	4	0.29b ( $\pm$ 0.29)
	100		100		0.00b ( $\pm$ 0.00)	1	0.07b ( $\pm$ 0.07)
		100	100		0.00b ( $\pm$ 0.00)		0.00b ( $\pm$ 0.00)



**Fig. 1.** Catches of *J. anatolica* male moths on a given date, Turkey, 2009. Arrows ( $\downarrow$ ) show the date of the beginning and end of tests. The traps were checked on May 28 in Serinyol and June 10 in Yayladağı.

pheromone of this species. The total catches of only two males of *A. obscura* do not allow us to draw conclusions about its possible sex attractant.

After the identification of 2-butyl (7Z)-tetradecenoate in the females of *H. metallica* (= *H. brillians*) (MYERSON *et al.* 1982), sex attractants for five Procrudinae species were found by field screening of the two enantiomers of the compound in North

America: the (*S*)-enantiomer attracted *H. metallica* (= *H. brillians*), *H. guatemalena* (DRUCE), and *Acolothus novaricus* BARNES & MCDUNNOUGH, while the (*R*)-enantiomer attracted *H. americana* (GUÉRIN-MÉNEVILLE) and *A. falsarius* CLEMENS (SODERSTROM *et al.* 1985, LANDOLT *et al.* 1986, LANDOLT, HEATH 1991). As a result of a field screening of *I. rotundata* synthetic sex pheromone components (the same as in

the present study) in Bulgaria, Ukraine and Hungary, sex attractants were found for five Procrinae species: (2*R*)-butyl (7*Z*)-dodecenoate alone or in combinations with other compounds, attracted numerous males of *Jordanita (Tremewania) notata* (ZELLER) in Bulgaria and Ukraine. Males of *Adscita (Adscita) geryon* (HÜBNER), *Adscita (Tarmannita) mannii* (LEDERER) and *Adscita (Adscita) albanica* (NAUFOCK) were recorded in traps baited with lures containing (2*S*)-butyl (7*Z*)-dodecenoate and *Rhagades (Rhagades) pruni* (DENIS & SCHIFFERMÜLLER) males were caught mainly in traps baited with (2*R*)-butyl (7*Z*)-dodecenoate as well as in traps baited with the latter compound and its enantiomer (SUBCHEV *et al.* 2010). In another field screening study in Armenia, using the same synthetic *I. rotundata* compounds, R-7-12 was found to be attractive for *Zygaenoprocris taftana* (ALBERTI) males while the mixture of R-7-12 + S-7-12 seemed to be the most attractive bait for males of *Jordanita (Rjabovia) horni* (ALBERTI) (EFETOV *et al.* 2010). SUBCHEV *et al.* (1998) identified R-7-14 as a main sex pheromone component in *T. ampellophaga* females. The (*S*)-enantiomer found as a minor sex pheromone component in female extracts (SUBCHEV *et al.* 1998; erratum) did not inhibited the attraction of *T. ampellophaga* males to its enantiomer in the field and even showed some attractiveness by itself (SUBCHEV *et al.* 2004). Thus, the catches of *T.*

*ampellophaga* males in traps baited with S-7-14 in the recent study were not a surprise bearing in mind also the presence of vine plants (*Vitis vinifera* L.) at the places of our investigations.

*J. anatolica* is distributed in Iran, Azerbaijan (Nakhichevan), Iraq, Southern Turkey, Cyprus, some Eastern Greek Islands, Syria, Lebanon, Israel, Jordan, Egypt and North-eastern Libya (EFETOV, TARMANN 1999, EFETOV 2001, 2004). In Turkey *J. anatolica* has been found so far in: Bitlis, Elazığ, Gaziantep, Hakkari, Hatay, İçel, Kahramanmaraş, Konya, Malatya, Maraş, Mardin, Muş, Şanlıurfa, and Van provinces (MOLLET 1995, KOÇAK & KEMAL 2007). The large number of *J. anatolica* caught during our study showed that this species to be highly abundant in the investigated places. The known host plants of the larvae belong to the genera *Echinops* and *Onopordum* (Asteraceae) (EFETOV 2001). Regarding EFETOV (2001), the species is univoltine, and its flight period is from the end of March to mid of July which coincides well with our observations. It is interestingly to notice that as a whole the flight in the second place of our study, Yayladağı, is somewhat later as compared to the flight in Serinyol which could be explained by a higher altitude of the former place.

This project was supported by Grant DO02-244/2008 of the Bulgarian National Scientific Fund.

## References

- EFETOV K. A. 2001. A Review of the Western Palaearctic Procrinae (Lepidoptera: Zygaenidae). Simferopol, Crimean State Medical University Press, 328 p.
- EFETOV K. A. 2004. Forester and Burnet moths (Lepidoptera: Zygaenidae). The genera *Theresimima* STRAND, 1917, *Rhagades* WALLENGREN, 1863, *Zygaenoprocris* HAMPSON, 1900, *Adscita* RETZIUS, 1783, *Jordanita* VERITY, 1946 (Procrinae), and *Zygaena* FABRICIUS, 1775 (Zygaeninae). Simferopol, Crimean State Medical University Press. 272 p.
- EFETOV K. A., G. M. TARMANN 1999. Forester Moths: The genera *Theresimima* STRAND, 1917, *Rhagades* WALLENGREN, 1863, *Jordanita* VERITY, 1946, and *Adscita* RETZIUS, 1783 (Lepidoptera: Zygaenidae, Procrinae). Simferopol, Crimean State Medical University Press, 192 p.
- EFETOV K. A., M. A. SUBCHEV, T. B. TOSHOVA, V. M. KISELEV, W. FRANCKE 2010. Attraction of *Zygaenoprocris taftana* (ALBERTI, 1939) and *Jordanita horni* (ALBERTI, 1937) (Lepidoptera: Zygaenidae, Procrinae) by synthetic sex pheromones in Armenia. – *Entomologist's Gazette*, (submitted).
- HALLBERG E., M. SUBCHEV 1997. Unusual location and structure of female pheromone glands in *Ino ampellophaga* BAYLE (Lepidoptera, Zygaenidae). – *Int. J. Insect. Morphol. & Embryol.*, **25** (4): 381-389.
- KOÇAK A., M. KEMAL 2007. Revised and annotated checklist of the Lepidoptera of Turkey. Priamus, Serial Publication of the Centre for Entomological Studies Ankara, **8**: 144.
- LANDOLT P. J., R. R. HEATH 1991. Zygaenidae trapped with enantiomers of 2-butyl (Z)-7-tetradecenoate. – *J. Lepidopter. Soc.*, **45** (1): 63-65.
- LANDOLT P. J., R. R. HEATH, P. E. SONNET, K. MATSUMOTO 1986. Attraction of *Harrisina americana* and *Acoloitus falsarius* males (Lepidoptera: Zygaenidae) to (R)-(-)-2-butyl-(Z)-tetradecenoate. – *Environ. Entomol.*, **15** (4): 959-962.
- MOLLET B. 1995. Contribution a la connaissance des Procrinae de Turquie et des îles grecques de l'est de la mer Egée (Lepidoptera, Zygaenidae). – *Linneana Belgica*, **15** (3): 127-136.
- MYERSON J., W. F. HADDON, E. L. SODERSTROM 1982. Sec-butyl (Z)-7-tetradecenoate. A novel sex pheromone component from the western grapeleaf skeletonizer, *Harrisina brillians*. – *Tetrahedron. Lett.*, **23**: 2757-2760.
- SODERSTROM E. L., D. G. BRANDL, J. MYERSON, R. C. BUTTERY, B. E. MACKAY 1985. Sex pheromone for attracting western

- grapeleaf skeletonizer (Lepidoptera: Zygaenidae). – *J. Econ. Entom.*, **78** (4): 799-801.
- SUBCHEV M. 2003. An unusual pheromone system in *Theresimima ampellophaga* (BAYLE-BARELLE, 1808) (Lepidoptera: Zygaenidae, Procrarinae) – a separate pathway in the evolution of the sex pheromone communication system in Lepidoptera, pp. 145–150, 1 fig. In: EFETOV, K. A., TREMEWAN, W. G. & TARMANN, G. M. (Eds.), Proceedings of the 7th International Symposium on Zygaenidae (Lepidoptera) Innsbruck (Austria), 4-8 September 2000. Simferopol, Crimean State Medical University Press, 360 p.
- SUBCHEV M., A. HARIZANOV 1990. Sex pheromone communication of *Ino (Procris) ampellophaga* (Lepidoptera: Zygaenidae). Pheromones in Mediterranean pest management. Abstr. Symp. Use of pheromones and other semiochemicals in integrated control. Granada, 10-15 September, 44.
- SUBCHEV M., A. HARIZANOV, W. FRANCKE, S. FRANKE, E. PLASS, A. RECKZIEGEL, F. SCHRÖDER, J. A. PICKETT, L. J. WADHAMS, C. M. WOODCOCK 1998. Sex pheromone of the female vine bud moth, *Theresimima ampellophaga* BAYLE-BARELLE (Lepidoptera: Zygaenidae), comprises (2S)-butyl (7Z)-tetradecenoate. – *J. Chem. Ecol.*, **24**: 1141-1151; erratum: *J. Chem. Ecol.* **25**: 1203.
- SUBCHEV M., T. TOSHOVA, C. KOSHIO, S. FRANKE, A. TRÖGER, R. TWELE, W. FRANCKE, J. A. PICKETT, L. J. WADHAMS, C. M. WOODCOCK 2009. New sex pheromone compounds identified from females of the plum moth *Illiberis rotundata* Jordan. – *Chemoecology*, **19**: 47-54.
- SUBCHEV M., T. TOSHOVA, M. TÓTH, E. VOIGT, J. MIKULÁS, W. FRANCKE 2004. Catches of vine bud moth *Theresimima ampellophaga* (Lep., Zygaenidae: Procrarinae) males in pheromone traps: effect of purity and age of baits, design, colour and height of the traps, and daily sexual activity of males. – *J. Appl. Ent.*, **128** (1): 44-50.
- SUBCHEV M., K. A. EFETOV, T. TOSHOVA, E. V. PARSHKOVA, M. TÓTH, W. FRANCKE 2010. New sex attractants for species of the zygaenid subfamily Procrarinae (Lepidoptera: Zygaenidae). – *Entomol. generalis*, **32**: 4. (In print).
- TOSHOVA T., M. SUBCHEV 2005. Circadian rhythm and female calling and mating behaviour in procrarinae (Lepidoptera: Zygaenidae). – *Acta entomol. Bulg.*, **11** (1-2): 63-71.

Received: 20.05.2010

Accepted: 09.06.2010

## Нов полов атрактант за *Jordanita anatolica* (Naufock) (Lepidoptera: Zygaenidae: Procrarinae)

К. Ефетов, Ф. Кан, Т. Тошова, М. Събчев

### (Резюме)

Четири вещества – (2R)-бутил (7Z)-додеценоат, (2R)-бутил (9Z)-тетрадеценоат, (2S)-бутил (7Z)-додеценоат и (2S)-бутил (9Z)-тетрадеценоат и техни смеси са скринирани в лепливи „Делта“ ловилки на две места (Сериньол и Яйладагъ) в Югоизточна Турция. В резултат е уловено голямо количество мъжки на *Jordanita anatolica* (NAUFOCK) (Lepidoptera: Zygaenidae: Procrarinae), основно в ловилки с примамка смес 1:1 на (2R)-бутил (7Z)-додеценоат и (2S)-бутил (7Z)-додеценоат. Това е първо съобщение за полов атрактант за *J. anatolica*. Началото и краят на летежа на този вид не са точно установени по време на полевата работа, но от получените резултати може да се заключи, че той започва да лети преди средата на май и летежът свършва след 1 юли. По време на полевата работа са хванати още два вида. Един мъжки индивид на *Adscita obscura* (ZELLER) е намерен в ловилка с примамка (2S)-бутил (7Z)-додеценоат в Сериньол и друг в ловилка с примамка (2R)-бутил (7Z)-додеценоат + (2S)-бутил (7Z)-додеценоат в Яйладагъ. В ловилки с примамка допълнително скринираното вещество (2S)-бутил (7Z)-тетрадеценоат са се уловили общо на двете места 16 мъжки пеперуди на *Theresimima ampellophaga* (BAYLE-BARELLE).