autosomal complement consists of one pair of large, one pair of medium, and 7 pairs of small meta-submetacentrics; one pair of large and one pair of small subtelocentrics; and 7 pairs of medium to small acrocentrics. The *X*-chromosome is a medium-small acrocentric and the *Y*-chromosome is a small acrocentric equivalent in size to the smallest autosome. Karyotypes representative of three island populations are given in the Figure.

The discovery of the 38-chromosome form of the black rat in the Galápagos is not particularly surprising since these rats have the European appearance in all other respects.

It is of some interest, however, that the populations examined appear to epitomize a generality of a very low to non-existent level of chromosomal variability exhibited by all 'introduced' populations of black rats the world over. Despite a rather wide range in variability of expressed types of chromosomal rearrangements within the species as a whole, no population as yet from Africa, Australasia, or the Americas (all with $2n = 38$) has exhibited any form of chromosomal variability. This lack of variation at the chromosomal level is also paralleled by a similar consistent low level of genic-based variability as judged by allozyme studies[20]. Therefore, at least in the case of the black rat, exceptional colonizing ability is not associated with any increased genetic variance (as measured by chromosomal or genic characters) as might be expected. Quite to the contrary, the success of the species may be due instead to an extremely well-integrated and rigid genotype with extreme flexibility only at the phenotypic level[21].

Resumen. Muestras de ratas negras (*Rattus rattus*) de siete islas del Archipiélago de Galápagos fueron examinadas para estudios de chromosomas. El número diploide de todos los animales es 38 y los cariotipos son idénticos a los de las poblaciones europeas, americanas, y australianas. La conclusión general es que la falta de variabilidad cariotípica de las poblaciones introducidas se explica por la capacidad de ratas de establecerse por medio de cambios fenotípicos.

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Museum of Vertebrate Zoology, 2593 Life Sciences Building, University of California, Berkeley (California 94720, USA), 22 April 1974.

[20] J. L. PATTON, S. Y. YANG and P. MYERS, unpublished data.

[21] This research was supported in part by the Janss Foundation and the Penrose Fund of the American Philosophical Society and was accomplished during the joint Museum of Vertebrate Zoology, Natural History Museum of Los Angeles expedition to the Galápagos Islands, January and February 1974. We thank Dr. JOHN W. WRIGHT, CAROL P. PATTON and NANCY JO for aid in the field; Dr. TJITTES DEVRIES and the staff of the Charles Darwin Research Station for logistical support; and the Servicio Forestal and Parque Nacional Galápagos for collecting permits.

Sex Attractant Inhibitors of the Codling Moth *Laspeyresia pomonella* L.

Sex attraction in lepidoptera is often inhibited by compounds closely related to the attractant chemical, but differing by the position or geometry of a double bond or the presence or absence of an ester function[1,2]. Due to their effectiveness in counteracting response to pheromones, inhibitors may have a potential use in insect control.

In a search for strong inhibitors of the codling moth, *Laspeyresia pomonella*, sex pheromone, we have employed the routine procedure[1] of adding various chemicals[3] to cylindrical traps baited with *trans*-8, *trans*-10-dodecadien-1-ol[4] (Codlemone[5] caps) or with 3 virgin females. The tests with different chemicals were conducted over various time intervals in apple orchards at Opfershofen and Tägerwilen during the codling moth flights of 1972 and 1973.

The Table lists the catches with each chemical as compared with those of the control group over the same time period. Of all compounds tested, *cis*-8-dodecenyl acetate was the strongest codling moth inhibitor. Catch was reduced by ca. 90% with 1 mg of this chemical (No. 16), and almost totally with 5 mg (No. 17). Instead of codling moths, these traps attracted males of the plum fruit moth, *Grapholitha funebrana*, probably from stands of plum trees outside the apple orchard. *Cis*-8-dodecenyl acetate has been known as a sex attractant of this insect[6]. Compared with catches with this chemical alone, Codlemone seemed to have no effect on plum fruit moth males.

A number of other chemicals also significantly inhibited codling moth attraction. 3 compounds were tested against virgin females, *cis*-8-dodecenyl acetate (16 and 17) which was a strong inhibitor, and *cis*-10 and *trans*-10-dodecenyl acetate (Nos. 21 and 22) which were moderate inhibitors of Codlemone. All 3 chemicals were strong inhibitors of male attraction to females. As strong evidence has been obtained for the identity of *trans*-8, *trans*-10-dodecadien-1-ol with the natural codling moth pheromone[7], our results seem to suggest that the females emit this compound at a lower rate than Codlemone caps since their attractancy was reduced more drastically by inhibitors.

Structures of codling moth inhibitors found in this study are listed in the Figure in order of decreasing inhibition. Although prolonged tests might have altered the

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[3] *Cis*-2 through *cis*-5-dodecenyl acetates and alcohols were synthesized from the corresponding ω-acetylenic alcohols and alkyl bromides, the *cis*-6 isomer from 5-bromopentan-1-ol and 1-heptyne, as in W. L. ROELOFS and H. ARN, Nature, Lond. *219*, 513 (1968). Purities were about 90% by GLC. *Cis*-8-dodecenyl acetate was obtained from Zoecon Corporation as Funemone caps or from Farchan Chemicals; *trans*-8-dodecenyl acetate was a gift from Zoecon Corporation. Undecylenic alcohol and acetate were commercial grades. The remaining chemicals were kindly supplied by Drs. W. L. ROELOFS and A. HILL, Cornell University, Geneva, N. Y., USA.

[4] W. L. ROELOFS, A. COMEAU, A. HILL and G. MILICEVIC, Science *174*, 297 (1971).

[5] Trade name of Zoecon Corporation, Palo Alto, California, USA.

[6] J. GRANGES and M. BAGGIOLINI, Revue suisse Vitic. Arboric. *3*, 93 (1971).

[7] M. BEROZA, B. A. BIERL, H. R. MOFFITT, Science *183*, 89 (1974); L. M. McDONOUGH and H. MOFFITT, Science *183*, 978 (1974).

Effect of various chemicals on moth catch with Codlemone and codling moth females

Chemicals added to Codlemone [a] No.		Male catch [b] *L. pomonella* L. with/without test chemical	*H. nubiferana* Haw. with/without test chemical	Other species caught [c]
1	10-Undecen-1-ol (5 mg)	128/180		
2	10-Undecenyl acetate (5 mg)	167/180		
3	Dodecyl acetate	66/66		
4	*cis*-2-Dodecen-1-ol	13/28 [d]	12/19	
5	*cis*-2-Dodecenyl acetate	48/39		
6	*cis*-3-Dodecen-1-ol	34/28	22/19	
7	*cis*-3-Dodecenyl acetate	34/21	31/49	
8	*cis*-4-Dodecen-1-ol	17/28	16/19	
9	*cis*-4-Dodecenyl acetate	40/21	19/49	
10	*cis*-5-Dodecenyl acetate	22/21	98/49	
11	*cis*-6-Dodecen-1-ol	22/28	24/28	
12	*cis*-6-Dodecenyl acetate	23/21	71/49	
13	*cis*-7-Dodecenyl acetate (5 mg)	68/91	3/242 [f]	
14	*trans*-7-Dodecenyl acetate	49/39		
15	*cis*-8-Dodecen-1-ol	30/49 [d]	2/68 [d]	*Celypha striana* Schiff.
16	*cis*-8-Dodecenyl acetate	6/49 [e]	0/68 [f]	*Grapholitha funebrana* Tr.
17	*cis*-8-Dodecenyl acetate (5 mg)	1/91 [f]	0/242 [f]	*Grapholitha funebrana* Tr.
18	*trans*-8-Dodecenyl acetate	15/39 [d]		
19	*cis*-9-Dodecenyl acetate (5 mg)	63/91	0/242 [f]	
20	*trans*-9-Dodecenyl acetate	46/39		*Caradrina morpheus* Hfng.
21	*cis*-10-Dodecenyl acetate	6/39 [d]		
22	*trans*-10-Dodecenyl acetate	14/39 [d]		
23	*cis*-9-Tridecenyl acetate	20/39		
24	*cis*-10-Tridecenyl acetate	10/45 [d]		
25	*cis*-11-Tridecenyl acetate	10/45 [d]		
26	*cis*-8-Tetradecenyl acetate	38/23		*Spilonota ocellana* F.
27	*trans*-8-Tetradecenyl acetate	98/62		
28	*cis*-9-Tetradecenyl acetate	30/39		
29	*trans*-9-Tetradecenyl acetate	21/39		*Brytropha terrella* Hb.
30	*cis*-10-Tetradecenyl acetate	47/68		*Apotomis corticana* Hb. *Endothenia carbonana* Dougl. *sensu* Bradley
31	*cis*-11-Tetradecenyl acetate	16/39		*Yponomeuta padellus-malinellus* Gi.
32	*trans*-11-Tetradecenyl acetate	10/45 [d]		*Croesia holmiana* L.
33	*cis*-12-Tetradecenyl acetate	31/39		
34	*trans*-12-Tetradecenyl acetate	31/39		
Chemicals added to codling moth females				
16	*cis*-8-Dodecenyl acetate	16/226 [f]		*Grapholitha funebrana* Tr.
17	*cis*-8-Dodecenyl acetate (5 mg)	1/226 [f]		*Grapholitha funebrana* Tr.
21	*cis*-10-Dodecenyl acetate	4/106 [e]		*Grapholitha funebrana* Tr.
22	*trans*-10-Dodecenyl acetate	5/106 [e]		*Argyroploce aurofasciana* Hw.

[a] Alcohols were dispensed from rubber septa, esters from polyethylene caps, except in No. 1 and 3 (reversed). The amount applied was 1 mg, unless indicated. [b] Total catch of 4 traps each in test and control group, except No. 13, 17 and 19 (6 traps). Differences are significant at the 5% [d], 1% [e] and 0.1% [f] levels, respectively. [c] We wish to thank Professor W. SAUTER (Entomologisches Institut der ETH, Zürich) for identification of our specimens.

sequence somewhat, our results appear to agree with the theory of inhibition by chemicals showing affinity for the attractant receptor site[1]. Inhibitors found in these tests have a double bond in common with the attractant and a straight chain of 12 and 13 or, in 1 case, 14 carbon atoms. *Cis*-2-dodecen-1-ol (4) would fit the hypothetical receptor only when rotated as shown. *Cis*-isomers seem to be stronger inhibitors than *trans* (16 vs 18, 21 vs 22), acetates stronger than alcohols (16 vs 15). Other authors found *trans*-8-*trans*-10-dodecadienyl acetate to be a potent codling moth inhibitor[8].

Codlemone caps also attracted large numbers of *Hedya nubiferana* males between late May and the end of June of both years. This insect was never attracted to traps baited with codling moth females. It proved to be more sensitive to inhibitors than the codling moth (Table). As in the latter, strong inhibition was found with *cis*-8-dodecenyl acetate (16 and 17), but also with the corresponding alcohol (15) which was only a moderate codling moth inhibitor. *Cis*-7 and *cis*-9-dodecenyl acetate (13 and 19) which had no significant effect on codling moth catch, were also strongly inhibitory to *H. nubiferana*. Selective inhibition in insects using the same attractant has been proposed as a mechanism to achieve reproductive isolation[1,9]. Where attractants are used to monitor

[8] H. R. MOFFITT, commun. at 4th meeting of the IOBC working group on genetic control of codling moth and Adoxophyes, Wädenswil Nov. 27–29, 1973.

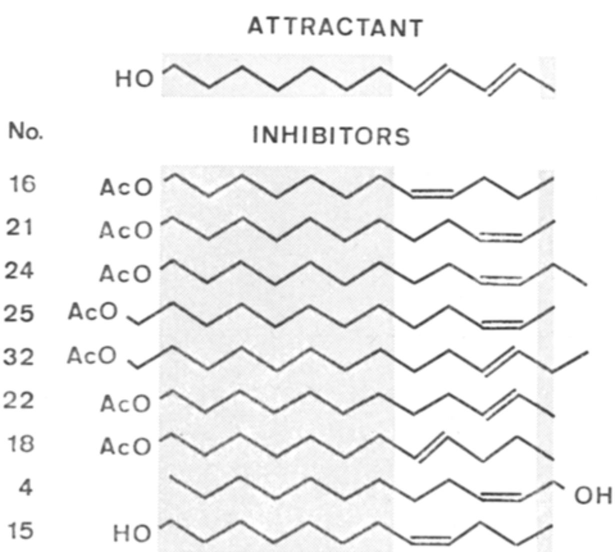
[9] M. C. GANYARD and U. E. BRADY, Nature, Lond. *234*, 415 (1971).

insect pests, the addition of selective inhibitors could provide a useful method to avoid capture of non-target insects that can cause unnecessary alarm to growers.

From the knowledge of inhibitors, no valid conclusions can at present be drawn on structures of sex pheromones. It is nevertheless interesting that 3 *H. nubiferana* inhibitors found in this study, *cis*-7 through *cis*-9-dodecenyl acetate, are also reported to be inhibitors of sex attraction in *Rhyacionia buoliana*[10].

Some compounds seemed to increase catches of *L. pomonella* (9 and 27) or of *H. nubiferana* (10 and 12) over the control, but this effect was in no case significant.

A number of other lepidoptera were specifically attracted to traps containing certain chemicals; whether the presence of Codlemone affected their catch is unknown. *Celypha striana* was attracted to *cis*-8-dodecen-1-ol (15), confirming an earlier observation[11]. Attraction of a *Bryotropha* species to *trans*-9-tetradecenyl acetate (29) has been observed in North America[12]. Of special interest is the capture of *Spilonota ocellana*, a widespread apple-feeder. About 100 males of this species were caught between June 27 and July 11 in 4 traps containing *cis*-8-tetradecenyl acetate (26). Catches of this species and those of *Apotomis corticana* and *Endothenia carbonana* with another 14-carbon compound (30) indicate that the attraction of *Olethreutinae* to 12-carbon compounds[13] may not be a general rule. Several *G. funebrana* males were caught in traps containing *L. pomonella* females and *cis*-10-dodecenyl acetate. Although no direct comparison could be made, this compound seemed less attractive than *cis*-8-dodecenyl acetate.



Structural similarities between codling moth sex attractant and inhibitors.

Conclusive evidence for the use of inhibitors in insect control has not yet been established. In a preliminary test in connection with a plum fruit moth confusion experiment[14], evaporation of *cis*-8-dodecenyl acetate from several sources within an apple orchard at the rate of ca. 150 to 600 mg per day and hectare did not prevent codling moth males from being recaptured in Codlemone- or female-baited traps. Similar results were obtained in Australia with the oriental fruit moth and the inhibitor dodecyl acetate[15]. On the other hand, orientation of codling moth males to females was successfully prevented over a short period with relatively large doses of *trans*-8, *trans*-10-dodecadienyl acetate[8].

Many insights into the mechanism of sex attractant inhibiton were obtained with compounds that recently proved to be synergistic at low levels[16]. Further studies will be needed to determine the actual effect of inhibitors on the various phases of mating behavior.

Zusammenfassung. Die Anlockung von Männchen des Apfelwicklers (*Laspeyresia pomonella* L.) mit *trans*-8, *trans*-10-Dodecadien-1-ol (Codlemone) oder mit lebenden Weibchen wird durch verschiedene Analoge des Sexuallockstoffs gehemmt. Starke Inhibitorwirkung zeigte *cis*-8-Dodecenylacetat. Der graue Knospenwickler, *Hedya nubiferana* Haw., der ebenfalls durch Codlemone angelockt wird, reagiert spezifisch auf weitere Inhibitoren.

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Some Observations on the Seed Coat Structure within the Genus *Epilobium*

The genus *Epilobium* is a very variable one whose species exhibit a wide range of morphological flexibility[1]. It is not surprizing then to read in the literature that there may well be over 200 species throughout the world within this genus[1–2]. Furthermore the complexity of the genus has led to much difficulty in determining the distribution patterns of the various taxa, simply because of the lack of knowledge of the total variability within species[3].

Despite the variable nature of the genus, autopolyploidy, rather than allopolyploidy, seems to occur in such variable species as *E. latifolium* and *E. angusti-*

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