International Journal of Multidisciplinary Research and Development

IJMRD 2014; 1(7): 135-139
www.allsubjectjournal.com
Received: 14-09-2014
Accepted: 27-10-2014
e-ISSN: 2349-4182
p-ISSN: 2349-5979
Impact Factor: 3.762

R. N. Parel
Department of Biological Sciences Rani Durgawati University Jabalpur, M.P.

Deepika Patel
Zoology and Biotechnology Research Lab Government Science College College Jabalpur, M.P.

Rita Bhandari
Zoology and Biotechnology Research Lab Government Science College College Jabalpur, M.P.

Uday Homkar
State Forest Research Institute (SFRI) Jabalpur M.P.

A. K. Gill
Adult and Rural Development of Department Durgawati university, Jabalpur M.P.

Correspondence:
R. N. Parel
Department of Biological Sciences Rani Durgawati University Jabalpur, M.P.

Potential of botanicals for the management of forest insect pests of Madhya Pradesh, India an overview

R. N. Parel, Deepika Patel, Rita Bhandari, Uday Homkar, A. K. Gill

Abstract
This paper reviews the botanicals evaluated against forest insect pests of India and presents the impact of neem and other plant products against major forest insect pests. Various neem products were found effective in field condition against many forest insect pests like the rohida defoliator, *Patialus tecomella,* the babul defoliator, *Taragama siva,* the desert locust *Schistocerca gregaria,* the babul whitefly *Acauldaleyrodes rachipora,* the spiralling whitefly, *Aleurodicus dispersus* and the teak defoliators *Hyblaea puera* and *Paliga machaeralis* etc. Neem oil and neem oil based formulations were used to contain the populations build up of *A. dispersus* on roadside plantations of *Bauhinia. variegata* and *Michelia champaca.* Neem cake, pongam cake and VAM were commonly applied in combination for the management of sucking pests on seedlings. Other than neem about 58 plant species were reported to have pest management properties on forest insect pests. In these plants, mostly crude extracts were reported to have different type of pest management properties in laboratory condition against defoliating pests. Not much work has been carried out on other group of insects like sap suckers, wood borers, gall inducers etc. Extractives of different parts of *Capparis decidua* were found to possess aphidicidal principles against three species of aphids *viz.*, *Aphis gossypii, Lipaphis erysimi* and *Mysus persicae.* Plant products other than neem were not practically used much for pest control. It is recommended to have national, regional and international coordinated effort to exploit botanicals that are more potent as an integral component of pest management in different cropping systems including forestry.

Keywords: Botanicals, forest insect pests, pest management.

1. Introduction
The use of synthetic pesticides during the last half century has often been careless and indiscriminate which resulted in malicious effects on the environment and leads to "ecological backlash" (Sundararaj, 1997). Concern about this has led to a surge of research into alternative pest control technologies. One of the efforts is the development of botanical insecticides as a novel and safer alternative strategy. Botanical insecticides, which contain plant extracts as active components, are safer as well as environmentally friendlier than synthetic insecticides. Use of these chemicals of plant origin, commonly called „botanicals" or „phytochemicals" have attracted particular attention because of their specificity to insect pests, their biodegradable nature and their potential for commercial application (Bishop and Thronton, 1997; Shukla *et al.,* 2000). These materials have been, since time immemorial, reported to be devoid of the various disadvantages, which are associated with the use of synthetics. Bioactivity of plant-based compounds is well documented in literature and is a subject of increasing importance. Knowledge of the toxic plants, their toxic principles and their biological activity is of paramount importance not only to enable them to be utilized as natural pest control agents and replace the commercial synthetic pesticides but also to enable us to understand the nature of their toxicity to non-targeted animals. The efficient use of such renewable natural resources is becoming increasingly important worldwide. There is no doubt that many plant secondary metabolites affect insect behaviour, development and reproduction. Characterization and identification of these Sundararaj 45 substances is an importantsubstances is an important first step in understanding the effect of plants on insect life. The botanicals thus obtained offer better compatibility with other biological pest control agents than that of the synthetics and this has brought them to sudden prominence in pest management programme.

2. Neem- A potential source of biopesticide

Neem (*Azadirachta indica*) products are known in use in India from time immemorial against noxious insects. Because of its legendary insect repellant and medicinal properties, it being identified as "the most promising of all plants" and at the present moment it is the source of most promising pesticides. More than 100 protolimonoids, limonoids or tetranortriterpenoids and some nonterpenoid constituents have been isolated from various parts of neem (Koul *et al*., 1990). From the neem seed extract alone, over 57 components have been isolated and identified (Jacobson, 1988). It is now well established that azadirachtin, the most important phagorepellent of neem kernels protects plants against insect attack. Bernays and Chapman (1977) indicated azadirachtin as the most potent antifeedant against insects like *Locusta migratatoria migratorioides* and *Schistocerca gregaria.* It exhibits strong antifeedant activity against locusts as well as growth inhibiting properties (Rembold *et al*., 1980). Neem kernel extracts or their oil repel insects, act as antifeedant, cause growth disruption, deformities or mortality and impairing egg production (Sieber and Rembold, 1983). The review offer further evidence for the impact of neem products against the major forest insect pests of India. The control of forest pests like poplar defoliator, *Pygaera cupreata* (Bhandari *et al.,* 1988), babul defoliator, *Taragama siva* (Sundararaj *et al.,* 1995), the rohida defoliator, *Patialus tecomella* (Sundararaj and Murugesan, 1995), the babul whitefly, *Acaudaleyrodes rachipora* (Sundararaj *et al.,* 1995; 1996, Sundararaj, 1999a, b), the teak defoliators, *Eutectona machaeralis* and *Hyblaea puera* (Kulkarni *et al.,* 1996; Remadevi and Raja Muthukrishnan, 1988; Murugan *et al.,* 1999; Sree *et al.,* 2008) using different neem products have been tested and found useful. Dubey and Sundararaj (2004) demonstrated neem oil as effective like that of commercial neem formulations and Chlorpyriphos in containing the nymphal populations of *A. disperses* infesting trees of *Michelia champaca* and *B. variegata*. Neem seed kernel suspension as effective repellent against the polyphagous desert locust *Schistocerca gregaria* was demonstrated (Pradhan and Jotwani, 1971; Singh, 1985; Sundararaj *et al*., 1985). Ramarethinam *et al*. (2002) repored insecticidal property of azadirachtin against *Eurema hecabe* on *Cassia fistula*, Ambika *et al*. (2007) recommended neem seed oil against *Pemplia morosalis* on Jatropha and Murugesan *et al*. (2008) recommended nimbicidin against *Carryedon serratus* infesting seeds of many forest trees. The application of neemcake alone or in combination with other seed cakes and VAM was recommended to control whiteflies in nurseries (Sundararaj, 2010). As the neem products proved its practical utility, they are recommended for large-scale application in forestry.

3. Other plant products

A perusal of literature revealed that other than neem about 58 plant species were reported to have pest management properties on forest insect pests (Table 1). Mostly crude extracts were found to have different type of pest management properties in laboratory condition against defoliating pests of teak, poplar, subabul, bamboo etc., without identifying the active principles in the plant products. Defoliating insects were mostly used as test insects except the report of Sharma *et al*. (1992) who reported insecticidal properties of 15 plant oils against the sap sucking psyllid *Heteropsylla cubana.* Similarly extractives of different parts of *Capparis decidua* were found to possess aphidicidal principles against three species of aphids viz., *Aphis gossypii* on marwar teak (*Tecomella undulata*), *Lipaphis erysimi* on mustard (*Brasicca compestris*) and *Mysus persicae* on cabbage (*Brassica oleracea*) (Table 2). The order of aphidicidal potential of extract is root > seed > stem bark > branch > wood. These plant products are probable sources of some biologically active agents for pest management for the future. Although the potential of various plant species in pest management has been demonstrated, the plants have not been exploited commercially (Srinivasan, 2012) and as of now except neem other botanicals are not practically used in pest control. Geden (2012) is of the view that further research on blends of essential oils with other botanicals and improved formulations and delivery systems could lead to substantial improvements in the performance of botanicals.

In conclusion synthetic insecticides have been used to contain insect populations since the inception of green revolution with the significant increase in crop production. However, the consequent pollution jeopardizes the agricultural as well as forestry business.

Table 1. Plant products other than Neem reported to have pest management properties against tree pests of India

Tree species	No. of plant species reported	Nature of plant products	Pest species and their nature	Effects	Reference
Acacia nilotica	1	Leaf powder: 1	**Seed feeders:** *Bruchidius* sp., and *Caryedon serratus*	Insecticidal	Murugesan *et al*., 2008
Ailanthes sp.	3	Leaf extract: 3	**Defoliator:** *Atteva fabriciella*	Antifeedant	Ahmed *et al*., 1991;
Bambusa balcooa *Bamboo* spp	6	Leaf extract: 6 Flower extract: 2	**Defoliator:** *Crypsiptya coclesalis*	Antifeedant	Kulkarni and Joshi, 1998; Kulkarni and Joshi *et al*., 1999; 2003
Termites		Resistant to degradation		Borthakur and Gogoi, 2009	
Dalbergia sissoo	5	Leaf extract: 5	**Defoliator:** *Plecoptera reflexa*	Antifeedant	Kulkarni *et al.,* 1997b, Meshram, 2000
Feronia elephantum	1	Leaf extract: 1	**Defoliator:** *Papilio demolius*	Antifeedant	Meshram *et al*., 1996

Gmelina arborea	1	Plant oil: 1	**Defoliators:** *Calopepla leayana* *Eupterote geminata*	Antifeedant	Singh and Sushilkumar. 1998
Leucaena leucocephala	15	Plant oil: 15	**Sap sucker:** *Heteropsylla cubana*	Insecticidal	Sharma *et al*., 1992
Pongamia pinnata	2	Leaf extract: 2	**Defoliator:** *Lamprosema niphaelis*	Growth inhibition	Deepa and Remadevi, 2007a
Poplar spp.	3	Bark extract: 1 Leaf extract: 2 Root extract: 1	**Defoliator:** *Clostera cupreata*	Antifeedant	Ahmad *et al*., 1997
Tamarindus indica	1	Leaf powder: 1	**Seed feeder:** *Bruchidius* sp., and *Caryedon serratus*	Insecticidal	Murugesan *et al*., 2008
Tectona grandis	36	Bark extract: 5 Leaf extract: 27 Seed extract: 4 Seed oil: 1 Tuber extract: 1 Wood extract: 1	**Defoliators:** *Hyblaea puera*	Antifeedant	Sundararaj *et al.,* 2004; Ramana *et al.,* 2004; Deepa and Remadevi, 2005; Senthil Nathan and Sehoon, 2006; Ramana and Himavathi, 2006; Ramana *et al*., 2007
Growth inhibition			Deepa and Remadevi, 2007b		
Insecticidal			Krishnakumar *et al*., 2011		
Larvicidal			Javaregowda and Naik, 2006;		
Ovicidal			Ramana, 2005		
Paliga machaerolis			Antifeedant	Meshram, 1995; Kulkarni *et al.,* 1997a; Murugesan *et al*., 2003 ; Sundararaj *et al.,* 2004; Durairaj, 2009	
Growth inhibition			Sree *et al*., 2008		

Table 2. Efficacy of extracts of *Capparis decidua* on different species of aphids

Seed		Branch		Bark		Root	
Aphis gossypii	*Tecomella undulata*	Dipping	94.85	91.20	70.28	97.24	100.00
Spraying	90.00		80.00	60.00	84.66		100.00
Lipaphis erysimi	*Brasicca compestris*	Dipping	96.64	90.00	73.32	96.64	100.00
Spraying	93.33		80.00	66.66	80.00		100.00
Mysus persicae	*Brassica oleracea*	Dipping	93.33	92.10	76.64	98.20	100.00
Spraying	90.00		90.00	73.33		76.66	100.00
CD (P= 0.05%)	5.76		4.86	6.12		8.04	NS

4. References

1. Ahmad M, Gupta BK, Bhandari RS. Efficacy of some plant extracts against *Ailanthes* web worm *Atteva fabriciella*. *Indian Journal of forestry*, 1991; 14(1):5-7.
2. Ahmad M, Dayal R, Mishra RK, Dobhal PC. Antifeedant potency of some plants produce against defoliating pest of poplar, *Clostera cupreata*. *Indian Forester*, 1997; 123(9): 821-826**.**
3. Ambika S, Manoharan T, Stanley J, Preetha G. Biology and management of *Jatropha* shoot webber. *Indian Journal of Entomology*, 2007; 69(3):265-270.
4. Bernays EA, Chapman RF. Deter chemicals as basis of oligophagy in *Locusta migratoria*. *Ecological Entomology,* 1977; 2:1.
5. Bhandari RS, Lal J, Ayyar KS, Singh P. Effect of neem seed extractives on Poplar defoliator, *Pygaera cupreata* Butler (Lepidoptera: Notodontidae) in laboratory. *Indian Forester*, 1988; 114:790-795.
6. Bishop CD, Thornton IB. Evaluation of the antifungal activity of the essential oils of *Monardo citriodora* var. *critriodora* and *Melaleuca alternofloia* on post-harvest pathogens. *Journal of Essential Oil Research,* 1997; 9:77-82.
7. Borthakur RD, Gogoi PK. Studies on dimensional stability and termite resistance capacity of bamboo (*Bambusa balcooa*) after treatment with chemicals and plant extracts. *Indian Forester,* 2009; 135(9):1217-1231.
8. Crosby DG. Naturally occurring insecticides. Jacobson, M, Crosby, D. G. Marcel Dekker, New York, 1971; 177-242.
9. Deepa B, Remadevi OK. Larvicidal activity of the wood extract of *Pterocarpus marsupium* on the 3rd instar larvae of *Hyblaea puera* (Hyblaeidae), the defoliator pest of the teak (*Tectona grandis*). *Advances in Indian Entomology: Productivity and Health*, 2005; 2:97-100.

10. Deepa B, Remadevi OK. Efficacy of plant products against the teak defoliator *Hyblaea puera* Cramer (LepidopteraHyblaeidae). *Pest Management in Horticultural Ecosystem*, 2007a; 13(1):68-70.
11. Deepa B, Remadevi OK. Growth-inhibiting efficacy of various plant extracts on *Lamprosema nephaelis* (Pyralidae: Lepidoptera). *Indian Journal of Plant Protection*, 2007b: 35(1):106-107.
12. Deepa B, Remadevi OK. Insecticidal activity of the leaf extract of *Dodonaea viscosa* Linn. (Sapindaceae) on teak defoliator, *Hyblaea puera* Cramer (Lepidoptera: Hyblaeidae). *Recent Trends in Insect Pest Management*, 2008, 228-230.
13. Dubey AK, Sundararaj R. Evaluation of some neem products against *Aleurodicus dispersus* Russell (Aleyrodidae: Homoptera) on *Bauhinia racemosa* and *Michelia champaca.*). *Indian Journal of Plant Protection*, 2004; 32(2):126-128.
14. Durairaj S. Preliminary efficacy of *Parthenium* extract on the feeding pattern of *Eutectona machaeralis*. *Insect Environment,* 2009; 14(4):153-154.
15. Geden CJ. Status of biopesticides for control of house flies. *Journal of Biopesticides*, 5 (Supplementary):2011, 1-11.
16. Jacobson M. The chemistry of neem tree. In: *Focus on Phytochemicals. Vol.1. The Neem Tree* (Jonus, P.S. *et al.*), 1988, 19-45.
17. Javaregowda, Krishana Naik L. Ovicidal properties of plant extracts against the eggs of teak defoliator, *Hyblaea puera* Cramer. *Karnataka Journal of Agricultural Sciences*, 2006; 20(2):291-293.
18. Koul O, Isman MM, Ketker CM. Properties and uses of neem, *Azadirachta indica. Canadian Journal of Botany.* 1990; 68:1-11.
19. Krishnaiah NV, Kalode MB. Efficacy of neem oil against rice insect pests under green house and field conditions. *Indian Journal of Plant Protection,* 1991; 19:11-16.
20. Krishna kumar N, Murugesan S, Senthilkumar N, Rajeshkannan C, Manicachakam P, Sumathi R. Vilvekam-*Aegle marmelos* seed oil based biopesticide for the management of teak defoliator. *Pestology*, 2011; 35(3):8-9.
21. Kulkarni N, Joshi KC. Feeding inhibition property of a common weed, *Ipomoea carnea* (Jacq.) ssp. *Fistulosa* (Austin) against bamboo leaf roller, *Crypsiptya coclesalis* (Walk.) (Lepidoptera: Pyralidae). *Allelopathy Journal*, 1998; 5(1):93-96.
22. Kulkarni N, Joshi KC, Gupta BN. Antifeedant property of *Lantana camara* var. *Aculeate* and *Aloe vera* leaves against teak skeletonizer, *Eutectona machaeralis* Walk. (Lepidoptera: Pyralidae). *Entomon*, 1997a; 22(1):63-67.
23. Kulkarni N, Joshi KC, Kalia S. Feeding inhibition property of some botanical extracts against sissoo defoliator, *Plecoptera reflexa* (Lepidoptera: Noctuidae). *Indian Journal of Forestry*, 1997b; 20(4):390-394.
24. Kulkarni N, Joshi KC, Rama Rao N. Screening of some plant extracts for feeding inhibition property against major forest insect pests. *My Forest*, 1996; 3(32):118-122.
25. Kulkarni N, Joshi KC, Shukla PK. Antifeedant activity of *Annona squamosa* Linn. against *Crypsiptya coclesalis* Walker (Lepidoptera: Pyralidae). *Entomon,* 2003; 28(4): 389-392.
26. Kulkarni N, Neelu Singh, Joshi KC, Lal RB. Activity of *Lantana camara* var. *aculeate* extract against the larvae or Bamboo leaf roller, *Crypsiptya coclesalis* (Walker) (Lepidoptera: Pyralidae). In: *Biopesticides in insect pest management*. (Ignacimuthu, S.J. and Alok sen, eds.), Phoenix publishing House Pvt. Ltd. New Delhi. 1999; 118-123.
27. Meshram PB. Evaluation of some medicinal and natural plant extracts against teak skeletonizer, *Eutectona machaeralis* Walk. *Indian Forester,* 1995; 121(6):528-532.
28. Meshram PB. Antifeedant and insecticidal activity of some medicinal plant extracts against *Dalbergia sissoo* Defoliator *Plecoptera reflex*a (Lepidoptera:Noctuidae) *The Indian Forester,* 2000; 126(9):961-965.
29. Meshram PB, Kulkarni N, Joshi KC. Antifeedant activity of Neem and *Jatropha* against the larvae of *Papilio demoleus*. *Journal of Environmentl Biology,* 1996; 17(4): 301-304.
30. Murugan K, Senthil Kumar N, Jeyabalan D, Senthil Nathan S, Sivaramakrishnan S. Neem as a effective Bio-pesticide to control teak defoliator *Hyblaea puera* (Cramer) (Lepidoptera: Hyblaeidae), *Journal of Non Timber Forest Products* 1999; 6(1/2):78-82.
31. Murugesan S, Ramsewak RS, Mattson WJ, Nair MG, Narayanan C, Mohan V. Antifeedant and antifungal compounds from *Dirca palustris. The Indian Forester*, 2003; 129(3):364-370.
32. Murugesan S, Sundararaj R, Prasanth Jacob J, Anitha J, Karthick S. Biopesticidal potential of neem against forest insect pests. *Hexapoda*, 2008; 15(1):56-60.
33. Singh N, kumar S. Biopesticidal plants from Indian forests and their role in insect pest management. **In:** *Ecofriendly Pest Suppression* (Gautam RD, Prasad D, eds.), Westvill Publishing House, New Delhi, 1998, 73-123.
34. Pradhan S, Jotwani MG. Neem kernels as antifeedant for locusts. *Sneha Sandesh,* 1971; 13:1-5.
35. Ramana P. Ovicidal evaluation of *Chromolaena odorata* extracts on teak defoliator-*Hyblaea puera* Cramer. *My forest*, 2005; 41(4):519-524.
36. Ramana P. Ovicidal evaluation of *Semecarpus kathalekanensis* extracts on teak defoliator, *Hyblaea puera* Cramer. *Journal of Non-Timber Forest Products*, 2006; 13(4):245-248.
37. Ramanna P, Bhat H. Antifeedant activity of some plant products against the larvae of teak defoliator, *Hyblaea puera* Cramer. *My Forest*, 2006; 42(4):323-326.
38. Ramana P, Patil SK, Rao KS. Antifeedant activity of *Holigarna* against larvae of teak defoliator, *Hyblaea puera*. *Journal Non-Timber Forest Products*, 2004; 11(2): 158-160.
39. Ramana P, Patil SK, Rao KS. Preliminary phytochemical screening and antifeedant evaluation of *Semecarpus kathalekanensis* Dasappa. *Indian Journal of Forestry,* 2007; 30(2):175-178.
40. Ramarethinam S, Loganathan S, Marimuthu S Murugesan NV. Potential of nimbicidine (0.03% Azadirachtin) in the control of *Eurema hecabe* (L.) infesting *Cassia fistula* L. (Caesalpiniaceae). *Pestology*, 2002; 26(12):5-10.
41. Rembold H, Sharma GK, Czoppelt Ch, Schmutterer H. Evidence of growth disruption in insects without feeding inhibition by neem seed fractions. *Z. PflKrankh. PflSchutz,* 1980; 87:290-297.
42. Senthilnathan S, Sehoon K. Effects of *Melia azedarach* L. extract on the teak defoliator *Hyblaea puera* Cramer (Lepidoptera: Hyblaeidae). *Crop protection*, 1980; 25:

287-291
43. Sharma HC, Leuschner K, Sankaram AVB, Gunasekhar D, Marthanda-Murthi M, Bhaskriah K *et al.* Insect antifeedants and growth inhibitors from *Azardiracta indica* and *Plumbago zeylanica*. **In:** *Natural pesticides from the Neem tree and other tropical plants* (Shmutterer, H. and Ascher, K.R.S., eds.), *Proc 2nd Int. Neem Conf.* (*Rausischholzhausen, Germany, 1983*), 1984, 291-320.
44. Sharma RN, Tare V, Pawar P, Vartak PH. Toxic effects of some plants oils and their common constituents on the psyllid pest, *Heteropsylela cubana* (Homoptera: Psyllidae) of social forestry tree *Leucaena leucocephala*. *Applied Entomology and Zoology*, 1992; 27(2):285-287.
45. Shukla AC, Shahi SK, Dikshit A. Epicarp of *Citrus sinensis*: a potential source of natural pesticide. *Indian Phytopathology,* 2000; 53:318-322.
46. Singh B. Studies on the effect of neem kernel extract and certain less persistent insecticides on the oviposition behaviour and mortality of the desert locust *(Schistocerca gregaria* Forsk.*) Ph. D. Thesis*, Agra university. India, 1985, 162.
47. Sree DS, Sankar NR, Sreeramulu. Evaluation of *thirteen medicinal plant extracts against teak (Tectona grandis)* leaf skeletonizer *Eutectona machoeralis* Walk. *Biomed,* 2008; 3(1):33-35.
48. Srinivasan R. Integrating biopesticides in pest management strategies for tropical vegetable production. *Journal of Biopesticides*, 5 (Supplementary): 2012, 36-45.
49. Sundararaj R. Evaluation of neem seed oil and some insecticides against the babul whitefly *Acaudaleyrodes rachipora* (Singh) (Aleyrodidae: Homoptera) on *Acacia senegal* seedlings. *Pestology*, 1997; 21(5):34-37.7.
50. Sundararaj R. Potential of neem products for the control of the babul whitefly on *Acacia tortilis* in nursery. *My Forest*, 1999a; 35(1):51-57.
51. Sundararaj R. Field evaluation of neem cake with biofertilizers and conventional fertilizeragainst the incidence of the babul whitefly *Acaudaleyrodes rachipora* (Singh) (Aleyrodidae: Homoptera) on *Acacia nilotica* seedlings. *Pestology,* 1999b; 22(12):9-12.
52. Sundararaj R. Potential of neem for forest insect pests management: an overview. In: Non-Chemical Insect Pest Management (Ignacimuthu S. and David, B. V. eds.). Elite Publishing House Pvt. Ltd., New Delhi, 2010, 15-25.
53. Sundararaj R, Murugesan S. Evaluation of Neem, *Azardirachta indica* (A. Juss) seed kernel powder against the rohida defoliator weevil, *Patialus tecomella* Pajni. *Journal of Applied Zoological Researches,* 1995; 6(2): 141-142.
54. Sundararaj R, Murugesan S, Mishra RN. Biopesticidal potential of neem against insect pests of arid zone. *Neem Newsletter of International Neem Network.* 1995; 2:8-10.
55. Sundararaj R, Murugesan S, Mishra RN. Field evaluation of neem seed oil against babul whitefly *Acaudaleyrodes rachipora* (Singh) (Aleyrodidae: Homoptera) on *Acacia senegal* seedlings. *Annals of Arid Zone,* 1996; 35(4):369-372.