

## Chapter 4

**NATURAL AND SYNTHETIC REPELLENTS**

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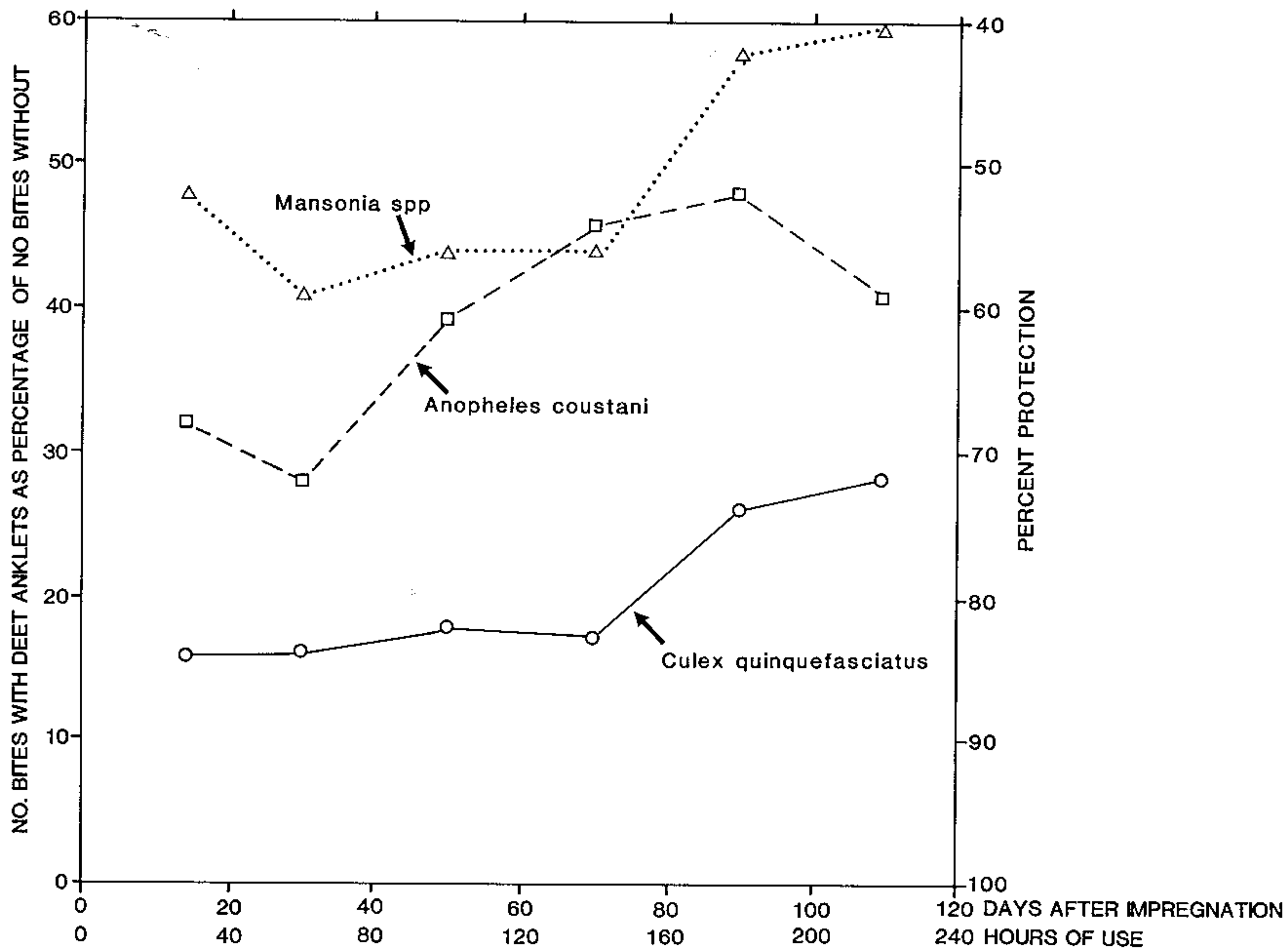


FIGURE 1. Results of tests with human subjects wearing deet-impregnated anklets.<sup>33</sup> The anklets were impregnated with 4 ml deet at the beginning of the study, were kept in a tin with a tight lid, and were brought out for testing for 2 h each evening. (From Curtis, C. F. et al., *Med. Vet. Entomol.*, 1, 116, 1987. With permission.)

good results were achieved against *Anopheles funestus*, but the protection against other species was not so good, presumably because they are not so rigidly programmed to bite on the lowest part of the body.

For protection from most malaria vectors there would only be any point in using repellents for protection in the evening if one was also well protected in bed. Deet has been used on broad mesh bed nets and has given many weeks of protection.<sup>72</sup> However, deet has now been superseded for this purpose by the impregnation of nets with synthetic pyrethroids, such as permethrin, which are almost completely nonvolatile and therefore last several months, and kill mosquitoes after brief contact, as described in Chapter 2.

Good results have also been reported with pyrethroids on clothing.<sup>73</sup> If the wearer remains within a limited area the mosquito attack rate declines over a few hours because an increasing proportion of the hungry mosquitoes have been incapacitated or killed by contact with the pyrethroid. In areas with intense mosquito biting a combination of permethrin-treated clothing plus deet on the exposed skin gave the best results.<sup>74</sup>

### C. CLOTHING AND REPELLENTS AGAINST VECTOR POPULATIONS OF *SIMULIUM*\*

In the savanna regions of seven west African countries onchocerciasis-transmitting populations of *Simulium damnosum s.l.* are being successfully controlled by spraying the riverine breeding sites with larvicides from helicopters.<sup>75</sup> This method is unsuitable in other parts of the world where human population densities are very low or where the flies breed in small or overgrown streams. In such cases personal protection against biting may be a more affordable option. The effectiveness of a citronella-based repellent against *Simulium* has been mentioned in Section I.E.1. Figure 2 shows the results of tests in Cameroon of the

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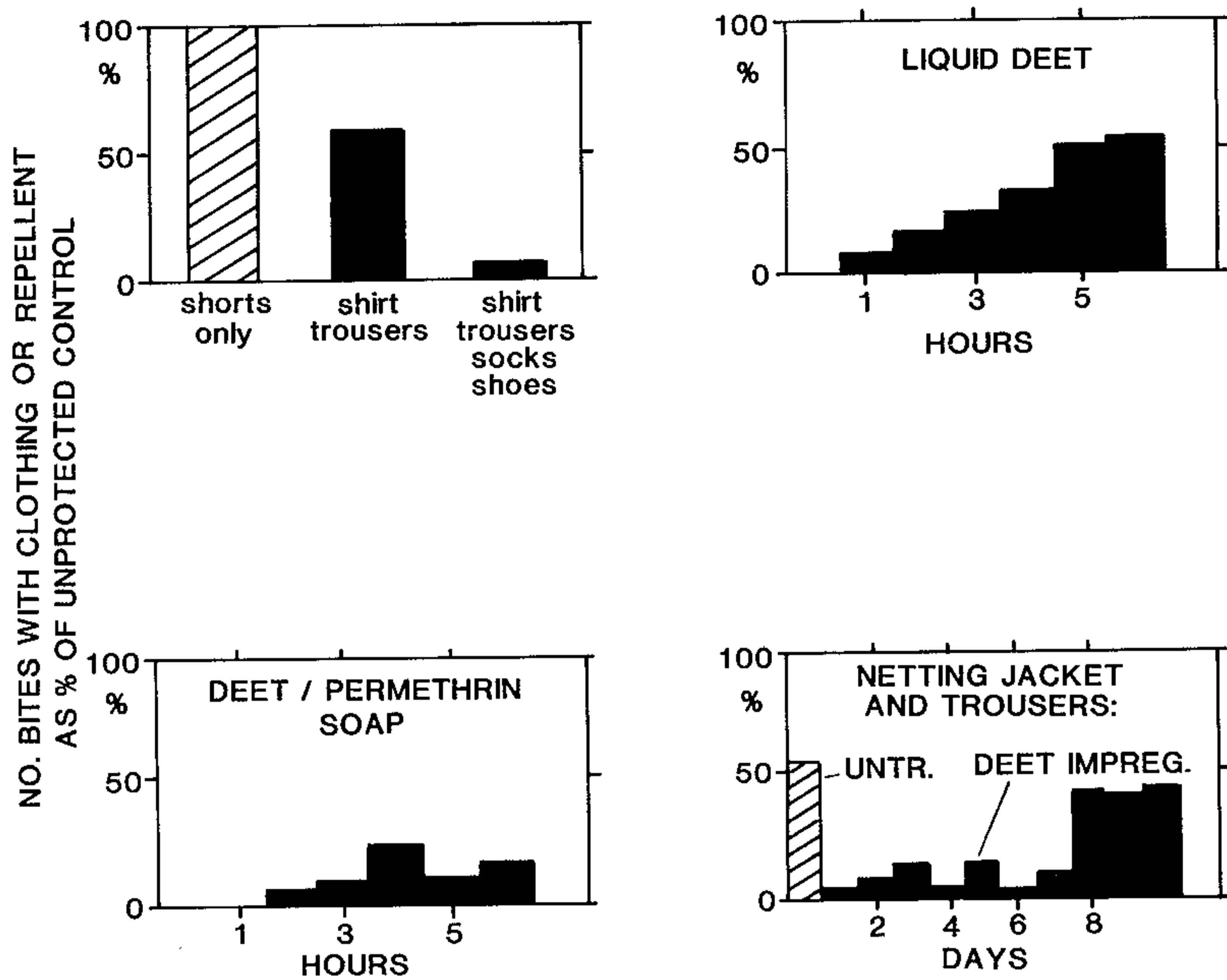


FIGURE 2. The effects of clothing, liquid deet, deet/permethrin soap, and deet-impregnated garments on biting by *Simulium damnosum* s.l. in Cameroon.<sup>60,62,76</sup> The amounts of repellent applied were 1 g liquid deet, soap containing 0.3 g deet and 0.04 g permethrin, netting jacket and trousers impregnated with 120 g deet.

effect on the biting rate of *S. damnosum* s.l. of applying liquid deet or deet and permethrin soap to the legs, or the wearing of unimpregnated clothing or netting jackets and trousers impregnated with deet.<sup>60,62,76</sup> These populations of *Simulium* bite predominantly on the lower legs and feet, and the most effective measure was the wearing of unimpregnated long trousers, socks, and shoes. Unlike mosquitoes *Simulium* cannot bite through cloth because of its short nonpenetrating mouth parts. The effectiveness of liquid deet was high at first, but declined markedly over a 6-h period; however, deet/permethrin soap remained effective throughout that period. Deet-impregnated garments remained effective for several days if stored in plastic bags when not in use.

Flies which were prevented from biting the lower parts of the body by any of these protective methods were not diverted to the hands or face. It appears that *Simulium* of a particular species is programmed to bite a specific area of the exposed human body, and it does not vary this behavior even to crawl under clothing.<sup>60</sup>

Until about 30 years ago the people in the area of Cameroon concerned were almost naked, but nowadays clothing covering much of the body including the lower legs has become common, especially among adults. Furthermore, visits to the riverside where *Simulium* densities are far higher than elsewhere<sup>62</sup> have become less frequent because of the digging of wells etc. The onchocerciasis-transmission potential of a fly population is conventionally estimated from biting catches by collectors wearing only shorts and stationed on riverbanks. On this basis the task of reducing transmission to tolerable levels seems almost impossible. However, one should allow for the actual extent to which people visit the riverbanks and wear clothes and for the fact that prolonged cumulative exposure to infection is necessary for the ocular lesions of onchocerciasis to appear. Taking these facts into consideration the task appears much less formidable. A real impact on disease transmission could be made by:

1. The increase, which will probably continue, in the amount of clothing worn.
2. Making deet available; it is appreciated as much for its repellency to the very annoying biting midges, *Chrysops*, tsetse, and sweat bees as to *Simulium*.
3. Making people aware of the danger of spending long periods near the rivers; young boys should be a particular target of such educational efforts as many of them spend many hours a day, almost naked, fishing and swimming in the rivers.

### III. ELECTRICAL GADGETS FOR PROTECTION FROM MOSQUITOES\*

Small electric heating plates for vaporizing mats (tablets) of volatile pyrethroids, such as bioallethrin, are now widely available. Tests<sup>20</sup> showed considerably better results than those from burning mosquito coils containing natural pyrethroids mentioned above. With *An. gambiae* released into a small room the vapor from the mats prevented all landings on human subjects, produced knockdown within half a minute, and none of the mosquitoes recovered. The vapor from the mats continued to be emitted for 10 h and was still effective when an extractor fan was switched on. Even after switching the heating plate off and running the extractor for many hours, the vapor had left a deposit on the walls of the room which was insecticidal. In suitable circumstances vaporizing mats could provide an alternative to the use of bed nets against night biting mosquitoes, as well as being useful indoors before people go to bed. For use where there is no mains electricity there is a 12-V battery-operated version and one which runs on methylated spirits without a flame, but their performance in drafty situations such as on verandas or in tents remains to be critically tested.

Traps designed to attract insects with ultraviolet light and then electrocute them are effective against houseflies and blowflies. However, in comparison with humans they have low attractiveness to mosquitoes, and running them in a backyard produced no detectable reduction in mosquito biting rate on human subjects.<sup>77</sup>

Buzzers have been widely sold as mosquito repellents with the claim that they simulate the sound of a male mosquito and that this sound is repellent to mated females. The sound of the wing beat of females is attractive to males (see Chapter 9), but females do not appear to respond much to sound. In any case, the buzzers are set at a much higher frequency than that of mosquito wing beats. At least 12 studies all agree that there is no difference in the mosquito biting rate with buzzers switched on or off (e.g., References 78 to 81). In England two companies have been fined for making unsubstantiated claims in advertising buzzers. It is desirable that similar legal proceedings are taken in other countries where this is possible since not only are people being cheated out of considerable sums of money, but some are being given a false sense of security that buzzers will protect them from malaria.

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