Government of Karnataka
Department of Health & Family Welfare
Karnataka Health Systems Development Project

Prevention and Control of

Outbreaks

of

Meningococcal Meningitis

Office of the
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Karnataka Health Systems Development Project
Department of Health & Family Welfare
Bangalore.

CONTENTS

3.2. The capsular polysaccharides of the organism differentiate thirteen serogroups. Among these serogroups of *N. meningitidis*, only serogroup "A" is reported from India.

4. Source of infection and its transmission:

4.1. Primarily the "carriers" (humans, who carry the organism in nasopharynx without getting the disease) are the source of infection. Sometimes, the patients of meningococcal meningitis can also be the sourse of infection.

4.2. The infection is transmitted through droplets during sneezing, coughing and direct contact with nasopharyngeal secretions. There is no extra-human reservoir of the organism.

5. Incubation period:

The incubation period of the disease is between 2-10 days, **commonly 3-4 days**.

6. Pathogenesis:

As mentioned above, the organism is present in the nasopharynx of carriers. Some of these carriers may develop mild upper respiratory infection only. After entry into the nasopharynx of a host, the organism can adhere to and enter the nonciliated cells of the nasopharyngeal mucosa. This colonisation is not sufficient for causing meningitis. In some instances, the organisms transmigrate through these cells to the submucosal space, where they have access to enter capillaries and arterioles and lead to a systemic infection. In this whole process the antiphagocytic capsular and surface antigens play a major role. This acute systemic infection can be manifested in three ways: meningitis (most of the cases), meningococcemia without meningitis and meningitis with meningococcemia.

7. Risk factors:

- In endemic situation the attack rate is highest in children of 6 months to 1 year age group.
- About 50 per cent of cases occur in children below 5 years and 80-85 per cent of total cases occur in less than 25 years age group.
- Attending physicians, health personnel and household members of patients are at more risk of getting the disease.
- Overcrowding, enclosed population (hostel, jail, remand home etc.) and low socio-economic status can also increases the risk of disease spread.

schools, cinema halls

8. Clinical manifestations:

8.1. Meningococcal meningitis is commonly presented with sudden onset fever, headache, vomiting, photophobia, altered consciousness and stiff neck. There may be petechial rash, diastolic hypotension, focal neurological signs and convulsions. In severe case, patient is usually comatose. In patient under one year, the disease is usually presented with fever, irritability, lethargy, convulsion, bulging fontanelle, petechial rash, hypotonia, vomiting and neck rigidity.

The clinical presentations of meningococcal meningitis are indistinguishable from other acute bacterial meningitis.

8.2. When the disease is manifested as Meningococcemia, bacteremia and sepsis occur without meningitis. Three-fourth of such cases may develop characteristic petechial rash in axillae, flanks, wrists and ankles. About 10-20 per cent of all meningococcemia may lead to fulminating stage with vaso-motor collapse, shock and high fatality rate. **Both the types of the disease may co-exist in endemic and epidemic situations.**

9. Case fatality:

Injection with penicillin has been found to be most effective for successful treatment of patients. However, case fatality rate (CFR) can be, as high as, 30 per cent or more during epidemic mainly due to low public awareness, delay in hospitalisation and improper management. With early diagnosis, specific antibiotic therapy and other supportive measures, CFR can be brought down to 5-10 per cent.

10. Clinical laboratory findings:

Apart from Gram staining of CSF, clinical laboratory studies are of little value in establishing the diagnosis. In acute bacterial meningitis, which includes meningococcal meningitis, the characteristic CSF findings are:

- Colour: Turbid/Purulent
- Pressure: Increased
- Mononuclear cells: <50/cu.m.m.
- Polymorph cells: 200-3000/cu.m.m.
- Protein: > 45 mg/dl.
- Sugar: < 40 mg/dl.

11. Differential diagnosis:

The common diseases, which have clinical features almost similar to meningococcal meningitis are: other acute bacterial meningitis, cerebral malaria, encephalitis, aseptic meningitis and brain abscess. A thorough history taking, clinical examination and laboratory investigations can help to establish the diagnosis.

12. Laboratory confirmation of diagnosis:

12.1. Culture of meningococci from CSF is "the confirmatory test". But it is not a very easy method. Moreover, the culture becomes difficult after the patients have taken antibiotics. Other methods (serologic) include Counter immuno-electrophoresis (CIE) and Latex agglutination tests. Like Gram staining, these tests are also performed on CSF. The diagnostic rate is highest (70-80 per cent) with Gram staining and Latex agglutination. This can further be increased through combination of tests.

Techniques for Gram staining of CSF:

Atleast 20 drops (1 ml) of CSF should be collected in a sterile tube. **Do not refrigerate** but hold at room temperature before staining. Processing should start immediately after collection.

- Centrifuge CSF at 2000 rpm for 10 minutes
- Draw off the supernatant and reserve for Latex agglutination test.
- Use a drop of sediment to make a smear on a glass slide. Air dry and fix gently by passing through flame.
- Flood the slide with ammonium oxalate-crystal violet solution and let stand for 1 minute.
- Rinse gently with tap water and drain off excess water.
- Flood smear with Gram's iodine solution and let stand for 1 minute.
- Rinse with tap water as above.
- Decolourise with 95 % ethanol for 5-10 seconds.
- Counterstain with safranin for 20-30 seconds or carbol-fuchsin for 10-20 seconds.
- Rinse the slide with tap water and blot dry.

Results: Examine the smear under oil-immersion lens with bright field condenser. Meningococci appear intra- or extra-cellularly as Gram-negative coffee-bean shaped diplococci.

General method for performing Latex agglutination tests of CSF:

- Take about 0.5 ml of supernatant of centrifuged CSF.
- Shake the Latex suspension gently until homogenous.
- Place one drop of specific latex suspension on a ringed glass slide or disposable card.
- Add 30-50 micro-litre of CSF to suspension.
- Rotate by hand or by a rotator at 100 rpm for 2-10 minutes.

Results: Read under bright light without magnification.
Negative reaction: The suspension remains homogenous and slightly milky in appearance.
Positive reaction: Within 10 minutes, agglutination (visible clumping) of the latex particles occurs.

Demonstration of bacteria in the Gram stained smear made from the centrifuged deposit of cerebro-spinal fluid (CSF) is an easy and cost-effective method that can be used at Primary Health Centre level. In field situation, Latex agglutination test can be performed easily and satisfactorily.

12.2. When CSF samples are to be sent to laboratory, **refrigeration should not be done** and the samples are to be sent at room temperature with in 2 hours of collection. From each patient, about 3 ml of CSF should be drawn and collected in 4 small sterile tubes in divided quantity for biochemical, culture, microscopy and serological tests. **If the quantity of CSF drawn/collected is less, then the person sending the sample should decide upon which test(s) is to be done at laboratory.** In such situation, depending upon the facilities available, serology and microscopy are the best options in order of preference. Each sample should accompany detailed information as indicated below,

- Sample identification No.:
- Name of patient:
- Age:
- Sex:
- Complete address:
- Presenting features with duration:
- Provisional diagnosis:
- Treatment given:
- Date of collection:
- Test (s) to be done:

13. Clinical management:

13.1. Patients with meningococcal meningitis require supportive treatment, as well as, antimicrobial therapy. The primary areas of supportive treatment are:

- Bed rest
- Antipyretic
- Sedative
- Good nursing care
- Maintenance of fluid and electrolytes balance
- Prevention of respiratory complications in comatose patients
- Use of anticonvulsants in patients with convulsions

13.2. For antimicrobial therapy, **Crystalline benzyl penicillin is the drug of choice.**

- 300,000 to 400,000 units of penicillin/Kg body weight/day should be given by I.V. drip or in divided doses 2-4 hours.

Alternatively, Chloramphenicol can be given.

- The dose is 100 mg/Kg body weight/day intravenously in 6 hourly divided doses.

This treatment can be given for a total duration of 7 days. Patients become non-infectious after 24 hours of starting specific antimicrobial therapy. Therefore, **they should be kept separately for 24 hours after the starting of antibiotic.**

A four days course with penicillin has been found to be as effective as any longer course of antimicrobials. This fact has special relevance during outbreak situation. In large outbreak, even the great majority of patients can be successfully treated with a single dose of long acting oily preparation of injectable chloramphenicol (100 mg/Kg; maximum 3 gm. I.M) or long acting penicillin.

14. SURVEILLANCE:

14.1. Early warning signal: Like other epidemic prone diseases, surveillance is the most effective tool for prevention and control of outbreaks of meningococcal meningitis. If properly implemented, surveillance can generate early warning signal of an impending outbreak by detecting sudden increase in number of cases/deaths or its clustering in time and space. This early warning should enable the health authorities in confirming the diagnosis and controlling the outbreak at the earliest.

14.2. Case definitions: The prerequisite of a surveillance is identification of patients (cases). The following case definitions are to be used in the surveillance of meningococcal meningitis.

Case definitions of Meningococcal meningitis

Suspect case: Sudden onset fever, severe headache and stiff neck with or without skin rash.
In patient under one year of age, a suspect case occurs when fever is accompanied by a bulging fontanelle.

Probable case: Suspect case with vomiting and positive neck rigidity with or without positive Kernig's and Brudzinski's signs OR suspect case with either cloudy/purulent CSF or petechial skin rash.

Confirmed case: Suspect or Probable case AND any one of the followings:
positive CSF for Gram-negative diplococci in direct examination, detection of meningococcal antigen in CSF or positive cultivation of the organism from CSF/blood/skin rashs.

Kernig's sign is tested by passively extending the patient's knee when his hip is fully flexed. This movement causes pain and spasm of the hamstring group of muscles.

Brudzinski's signs is tested by passively flexing the patient's neck. This movement causes an involuntary flexion of hip, knee and arm joints.

Both these signs become positive when meningeal irritation affects the lower part of the spinal subarachnoid space.

Use of case definitions at different levels

The peripheral health workers (MPWs) will use the "suspect" case definition, while the Medical officers of PHC, CHC etc. will use the "probable" one. The "confirmed" definition will only be used by the hospitals where facilities for laboratory confirmation are available.

14.3. Type of surveillance: Two types of surveillance are necessary in context of meningococcal meningitis. Since clinical presentations of acute meningitis due to all causative bacteria and some other diseases (see differential diagnosis) are indistinguishable, PHCs (including sub-centres), CHCs, Taluk and Sub-Divisional hospitals should use "suspect" and "probable" case definitions for **passive surveillance** of acute meningitis. Whereas, all district hospitals and medical colleges should use "confirmed" case definition for the **sentinel surveillance** of meningococcal meningitis.

- PHC, CHC, Taluk & Sub-Div. hospital: Passive surveillance of acute Meningitis.
- District hospital & Medical college: Sentinel surveillance of meningococcal meningitis.

14.4. Identification of sentinel centres: The sentinel centres should include all medical colleges and district hospitals of the state. In medical college, Head of PSM Department can be the In-charge of the Centre. He has to act in close collaboration with Medicine, Pediatric and Pathology / Microbiology Departments. For District hospital, the Superintendent or his designated subordinate officer may be the In-charge of the Centre.

14.5. Collection of Information: For passive surveillance of acute meningitis, minimum information is to be collected. Information on **name, age, sex, address and date of onset** will be sufficient to continue vigil on the disease situation. This information should be compiled in a linelist manner. However, for sentinel centres, more epidemiological and laboratory information is to be collected on each case as per format in Annex-I.

14.6. Role of Medical college: Being sentinel centre having better facilities, the medical colleges in addition to the above will also

- Conduct antibiotic sensitivity/resistance and serogroup typing tests for the Centre, as well as, of the samples sent from the districts hospitals.
- Perform cross-checking of CSF samples (both +ve and -ve) sent from the district hospitals.
- Extend diagnostic support during epidemic situation.

14.7. Frequency of reporting: All the reporting centres should send monthly report. Formats for passive and sentinel surveillance centres are in Annex-II & Annex-III. The **regularity of complete reporting, including "Nil" report has to be ensured.**

In the event of impending/continuing outbreak, information should flow daily at all levels.

14.8. Flow of information: All the passive and sentinel centres should send monthly report to the District Health Officer through FAX or by special messenger within 3rd day of next month. However, the sentinel centres should also send a copy of the report to the state nodal officer through FAX/speedpost. The district health officer will send consolidated monthly report of his district, as per format in Annex-IV, to the state nodal officer within 7th day of next month by FAX/speedpost. The state nodal officer will send the monthly report of his state to NICD within 15th day of next month by FAX with a copy to CBHI. Format to be used at state level is in Annex-V . With gradual development of HMIS services, NICNET will be used in near future. Flow chart of information is in Annex-VI. **However, in case of emergency, FAX, telephone, telegram should be used for sending daily reports at all levels.**

14.9. Data utilisation & monitoring: The data generated / received at different levels are to be scrutinised and interpreted monthly for local utilisation. Comparison of data should be made with that of previous month of the same year and same month of the preceding years. Properly drawn charts and graphs can help in better understanding of the situation. **Special attention should be given to identify geographical clustering of cases at the earliest.**

14.10. Feedback: Regular feedback on the reports in form of acknowledgement, discussion during monthly meeting, clarification, appreciation, advice etc. should flow from higher to next lower level.

15. Notification of the disease:

15.1. Meningococcal meningitis is not a notifiable disease in India. Presently an institution based passive monthly reporting of cases and deaths exists in the country. These monthly reports from the States are compiled annually at Central level by CBHI (Central Bureau of Health Intelligence). Besides being passive, the reporting is sometimes irregular and incomplete. Thus, this system is ineffective to address the needs of health administrators to look for the trend and foresee any impending outbreak.

15.2. If there is a sudden increase or clustering of cases or deaths due to acute meningitis/meningococcal meningitis, information should be notified immediately (by telephone or FAX) to the next higher level. The district/state health authorities will be

responsible to initiate investigation. If the outbreak is confirmed, National Institute of Communicable Diseases (NICD), Delhi, should be notified forthwith.

16. Actions to be taken in impending outbreak:

- Immediate reporting of suspicion to the next higher health authority.
- Immediate arrangements for laboratory confirmation of diagnosis.
- Continued analysis and monitoring of information on cases and deaths on a spot map.
- Early institution of the specific treatment to patients.
- Monitoring of number of cases and deaths graphically in time frame.
- IEC regarding chemoprophylaxis of household contacts of patients.

17. Control of outbreak:

When an outbreak is reported, the Rapid Response Team should be activated and mobilised by the district/state health authorities for taking up and helping in early implementation of the following control measures.

17.1. Outbreak investigation:

With the first indication of an outbreak, a thorough investigation should be carried out immediately to

- confirm the outbreak
- confirm the laboratory diagnosis
- define the areas affected
- assess the magnitude of problem (morbidity and mortality) in terms of "Time", "Place" and "Person".

Appropriate and early recommendations to control the outbreak is the most important objective of this investigation. Format for writing the outbreak investigation report is in Annex-VII

In outbreak situation, laboratory confirmation of each case is neither required nor possible.

17.2. Strengthening of surveillance:

- Active surveillance of the cases and deaths should be started in the area by health staff. **For this "suspect" case definition can be used** in community.

- Daily reporting of cases and deaths should be started at all levels from periphery to State Health Directorate.

17.3. Patient care:

Provision should be made to treat and follow-up all cases at hospital/CHC/PHC. If the situation demands, "Camp hospitals" should be established in school buildings or similar structures. Earliest institution of specific antibiotic can cut down mortality drastically. Information already available on microbial sensitivity/resistance can give right direction in this matter.

17.4. Health Education:

- Vigorous IEC activity should be started to diffuse the fear and confusion, if any, in the community.

- Recognition of early features of the disease by the community members and importance of earliest hospitalisation are two most important areas of IEC.

- Household contacts, particularly those sleeping in the same room of patient, should be warned about the need to obtain immediate medical attention at the first sign of fever and/or headache.

17.5. Chemoprophylaxis:

Since all the contacts of patients are at a very high risk of getting the disease, they should receive chemoprophylaxis for 2-4 days with **Sulfadiazine tablet** as per following schedule:

- Adults: 1 gm 12 hourly
- School children: 500 mg 12 hourly
- Pre-school children: 250 mg 12 hourly

If the organism is resistant to Sulfa, **Rifampicin** can be given orally. The duration is 2 days. For adults 600 mg and for children 10 mg/Kg body weight to be given 12 hourly.

17.6. Immunisation:

The primary means of controlling epidemic of meningococcal meningitis is vaccination. **In India, bivalent vaccine (against serogroups "A" & "C") is presently imported from out side by the Central Govt., primarily for immunising the Haj pilgrims.**

Ideally, in an outbreak of meningococcal meningitis, whole of the community should be vaccinated to cut down the transmission of the disease. **One dose is sufficient as it is considered a booster following wide spread mild and subclinical upper respiratory infection due to *N. meningitidid* in the community.**

About 7-10 days are required for the development of immunity after vaccination, which is longer than the average incubation period of the disease. Thus, vaccination can not prevent the secondary cases. It also has no effect on established carriers.

In children below 2 years, the vaccine has poor immunogenic response. But, as the outbreak takes years to subside, **a second dose after 3 months** can be given to these children.

In a country like ours, it may not be feasible and economical to immunise the whole population. But, immunisation if and when decided, should be targeted to the high risk groups, who are to be identified at first. They include: clinicians, laboratory officials, health staff and people staying in segregated places (jail, hostel, residential school, barrack, camp, remand house etc.), as well as, in difficult terrain and remote tribal areas. Once these groups are identified, their vaccination needs to be started as rapidly as possible to achieve maximum benefit in terms of cases prevented. The period of immunity varies from 1-3 years.

Dose & route of immunisation

The vaccine after reconstitution with the diluent (supplied along with), should be used within 24 hours. The dose is 0.5 ml subcutaneously irrespective of age.

17.7. Other measures:

- Closure of schools and banning of large gatherings etc. have not been shown to be effective in curtailing the spread of epidemics.
- **The information of the outbreak should be provided to the geographically contiguous districts/states.**

ANNEX-I

NATIONAL DISEASE SURVEILLANCE PROGRAMME

Meningococcal meningitis

(Format for collecting information on individual case in sentinel centres)

Name of the Centre: District:

Patient's name: IPD Reg.No.:

Age: Sex:

Complete residential address: Address during last 10 days:

Chief complaints with duration: Fever:
Headache:
Nausea/vomiting:
Other (specify):

Date of onset:

Date of hospitalisation:

Clinical diagnosis:

Laboratory investigations & results:

Final diagnosis[#]:

Specific treatments given:

Out come: Cure & discharged/Died[@]/Absconded/LAMA[*]:

Date of outcome:

Additional information in case of Medical college:

- Antibiogram:
- Serogroup:

Level of information to count a "case".
@ Level of information to count a "death".
* LAMA: Left against medical advice

ANNEX-II

NATIONAL DISEASE SURVEILLANCE PROGRAMME
Meningococcal meningitis

(Format for sending report on Acute meningitis by PHC, CHC, and other Passive reporting centres)

Name of Centre: District:

Reporting month: Year:

Date of reporting:

Number of cases	Number of deaths

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* Cases include deaths also

Signature of in-charge
Date:

ANNEX-III.

NATIONAL DISEASE SURVEILLANCE PROGRAMME
Meningococcal meningitis

(Format for sending report on meningococcal meningitis by sentinel centres)

Name of the centre: District:

Reporting month: Year:

Date of reporting:

Age group (in years)	No. cases*		Total	No. deaths		Total
	Male	Female		Male	Female	
0 - < 1						
1 - < 5						
5 - 9						
10 - 14						
15 - 24						
25 & above						

* Cases include the deaths also.

Additional information in case of Medical college:

- Antibiogram:
- Serogroup:

Signature of In-charge
Date:

ANNEX-IV

NATIONAL DISEASE SURVEILLANCE PROGRAMME
Meningococcal meningitis

(Format for sending report by district health office)

Name of district:

Reporting month:

Date of reporting:

	Number of cases	Number of deaths
Acute meningitis		
Meningococcal meningitis		

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* Cases include deaths also

Signature of DHO
Date:

ANNEX-V

NATIONAL DISEASE SURVEILLANCE PROGRAMME
Meningococcal meningitis

(Format for sending report by state nodal office)

Name of state:

Reporting month:

Date of reporting:

	Number of cases*	Number of deaths
Acute meningitis		
Meningococcal meningitis		

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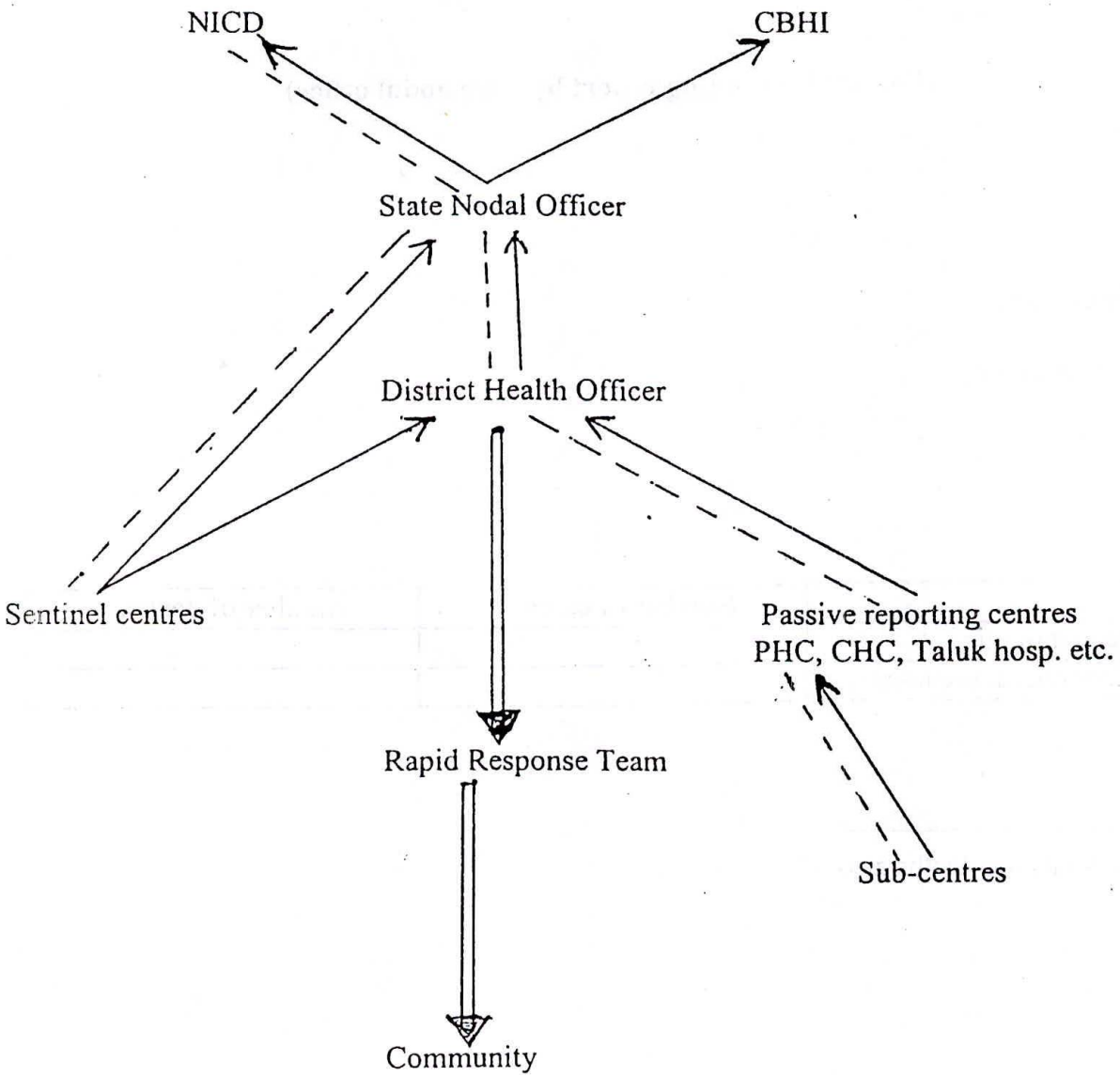
* Cases include deaths also

Signature of state nodal officer
Date:

ANNEX-VI

NATIONAL DISEASE SURVEILLANCE PROGRAMME
Meningococcal meningitis

Chart showing flow of information:



Direction of flow of report ——→
Direction of flow of feedback - - - - - →
Direction of action at community level ⟹

ANNEX-VII

NATIONAL DISEASE SURVEILLANCE PROGRAMME

(OUTBREAK INVESTIGATION REPORT)

General information:

State :.....

District :.....

PHC/Town :.....

Village/Ward :.....

Population :.....

Background information:

Person reporting the outbreak :.....

Date of report :.....

Date investigation started :.....

Person(s) investigating the outbreak :.....

Details of investigation:

Describe how cases were found (may include (a) house to house search in the affected area; (b) visiting blocks adjacent to the affected area; (c) conducting records review at local hospitals; (d) requesting health workers to report similar cases in their areas etc.).

Descriptive epidemiology:

- Cases by time, place and person (attach summary tables and relevant graphs and maps).
- Age-specific attack rate and mortality rates.
- High risk age group and geographical areas.

Description of control measures:

Description of measures for follow-up visits:

Brief description of problems encountered:

Factors which, in your opinion, contributed to the outbreak:

Conclusions and recommendations:

Vector Surveillance
Entomological & Vector Control Aspects

Division of Medical Entomology & Vector Control

National Institute of Communicable Diseases,
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VECTOR SURVEILLANCE

The last 3 decades has witnessed the emergence , resurgence or spread of vector-borne diseases like malaria, filariasis, Japanese encephalitis, Dengue/DHF, Kala-azar, plague in various parts of the country. Amongst the various reasons attributed contributing for the rising trend of vector-borne diseases, the inadequacy or lack of entomological surveillance is of paramount importance.

In view of the above it was thought worthwhile to gear up/strengthen entomological surveillance activities at various levels viz. District, Zonal, Regional, State and Central level to collect meaningful entomological data in respect of existing vector-borne diseases prevalent in the district and about the receptivity of the area for other vector-borne diseases. Some of the important characteristics of the vectors of various vector-borne diseases, sampling techniques, identification keys, techniques used for the incriminatioin of vector species for pathogens/parasites, WHO techniques to ascertain the insecticide susceptibility status of adults and immature stages and vector control measures used viz. personal prophylactic, source reduction, environmental management, biological control, chemical control and integrated measures used for the prevention and control of vector-borne diseases on long and short term basis are summarised below:

Entomological aspects

Most of vector-borne diseases prevalent in the country are transmitted by animals from 3 Classes viz. Insecta, Crustacea and Arachnida belonging to Phylum - Arthropoda (Arthros = Jointed, podos = legs). Members belonging to these Classes can easily be differentiated on the basis of following characters:

Class	Insecta	Crustacea	Arachnida
Body	Divisible into head,thorax and abdomen	Divisible into cephalothorax and abdomen	Undifferentiated
Legs	3 pairs	5 pairs	4 pairs
Antennae	1 pair	2 pairs	Absent
Wings	Present	Absent	Absent

1. Mosquitoes- Vectors of malaria, Dengue, filariasis and J.E.

Mosquitoes are worldwide in distribution. There are about 3450 species and subspecies of mosquitoes belonging to 38 genera in Family - Culicidae. In India there are about 300 species of mosquitoes.

Mosquitoes may be easily differentiated from other insects of similar shape and size on the basis of following characteristics:

i) Insects with a single pair of mesothoracic fore wings, and the hind pairs of wings are modified into halteres

ii) Presence of forwardly projecting proboscis with piercing and sucking types of mouth parts

iii) Presence of scales on the thorax, abdomen, legs and wing veins

iv) Presence of fringe scales on the posterior margin of the wings

v) Characteristic wing venation i.e. wing vein 2nd, 4th and 5th bifurcated

1.1 Morphology of mosquito -

Mosquitoes are slender bodied , small insects measuring about 3-6 mm. in length. However, some spp. may be as small as 2 mm, while others may be as long as 19 mm (*Toxorhynchites*). The body is distinctly divided into head, thorax and abdomen. Mosquitoes possess only one pair of functional mesothoracic forewings. The hind pair of wings are represented by a pair of small knob-like structures, the halteres, which are the balancing organ while mosquito is flying.

The head bears a pair of large kidney-shaped compound eyes and a pair of filamentous and segmented antennae. In females the antennae have whorls of short hairs (Pilose) whereas in males the antennae bear a whorl of long hairs giving them feathery appearance (Plumose). Just below the antennae, head bear a pair of maxillary palpi which may be short or long and dilated or pointed at their tips depending upon the sex and whether adults are anophelines or culicines. Arising between the palpi is a single elongated structure, the proboscis, which contains the piercing and sucking types of stylets or mouth parts. The largest component of the mouth parts is a long and flexible gutter - shaped labium which terminates in a pair of small lobe like structure called labella which are sensory in nature. The labium almost encircle all the other mouth parts and serves as a protective sheath.

The upper most structure, the labrum is slender, pointed and grooved along its ventral surface. In between the labrum and labium are five needle like structures viz . a pair of toothed maxillae, a pair of serrated mandibles, a single hollow stylet, the hypopharynx.

At the time of taking blood meal, the tips of flashy labium are placed on the skin and curves backwards. This allows the paired mandibles and maxillae, labrum and hypopharynx to penetrate the host skin. Saliva is pumped into the host body through the hypopharynx. Blood is ingested by females mosquito through the pumping action of the pharynx.

The male mosquitoes are incapable of taking blood meals as the maxillae and mandibles are vestigeal and feed on plant saps or nectar.

The thorax is covered dorsally and laterally with scales which may be dull or shiny, white, brown, black in colour. The arrangement of scales on the dorsal surface of the thorax helps in the identification of some species of mosquitoes (*Aedes* spp.)

The wings are long and relatively narrow, the number and arrangements of the wing veins is almost the same in all mosquito spp.The veins are covered with scales which are usually brown, black, white, creamy or yellow in colour. The shape of the scales and pattern of their distribution varies in different genera and species of mosquitoes. While sitting the wings of the mosquitoes are placed across each other over the abdomen in the form of a closed scissor. There are three pairs of tiny, elongated legs which are covered with scales. The tarsus usually terminates in a pair of toothed or simple claws. Some genera such as *Culex* have a pair of small fleshy pulvilli at the end of tarsus.

The abdomen consists of 10 segments but only the first 7 or 8 are visible.

In sub-family Culicinae, the abdomen is usually covered dorsally and ventrally with brown, black or white scales.

The last abdominal segment of the female mosquito terminates in a pair of small finger like structure called cerci, whereas in males it terminates in a pair of prominent clapers, which is a part of male gentalia. (Fig : 1)

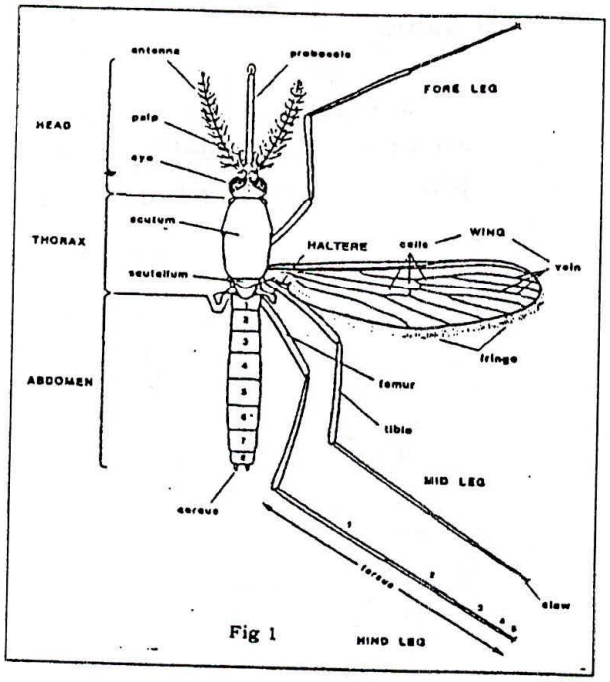


Fig 1

Diagrammatic representation of a female adult mosquito

1.2 <u>Anopheline Mosquitoes</u> :- Anopheles species are mainly responsible for the transmission of malaria in various parts of the world. Out of 55 anopheline species prevalent in India , 9 are vectors of malaria viz. *Anopheles annularis, A. stephensi, A. Philippinensis, A. sundaicus, A. minimus, A. varuna, A. culicifacies, A.fluviatilis* and *A. dirus.*

i) <u>Habits</u> :- They are commonly found in large numbers in human habitations, animal shelters or in mixed dwellings. Anopheline mosquitoes have also been found resting in outdoor situations on banks of stream , under culverts, and in thick shrub, forest etc.

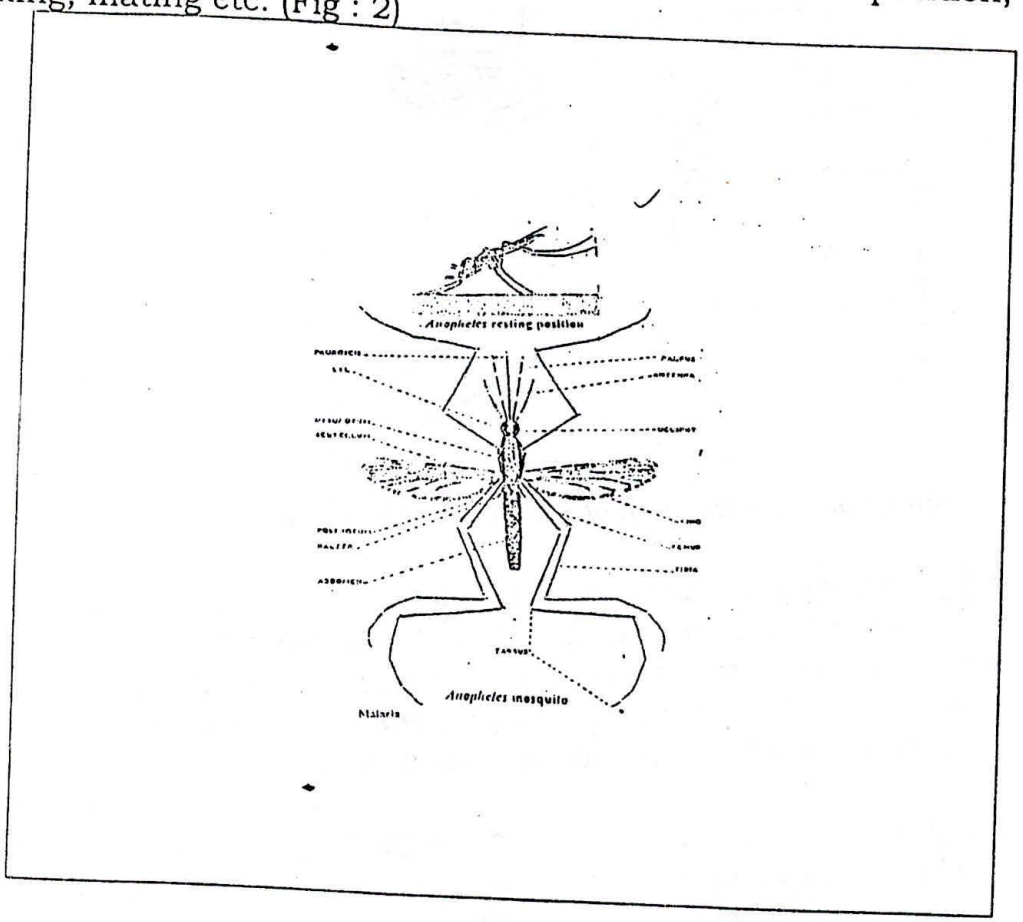
ii) <u>Breeding habits</u> :- The eggs are deposited singly and generally laid on the surface of clean and unpolluted water such as pools, rice fields, slow running streams, cisterns, overhead tanks, tree holes etc. Some species prefer standing types of water like ponds, wells, irrigation cannals, pits and also breed in various types of rain water collections.

iii) <u>Resting habits</u> :- Most of the anopheline mosquitoes are domesticated and they are found in very large number in indoor situations; in cattlesheds and human habitations. However some of the species like *A. dirus* is an outdoor rester (Exophilic). Males are usually found near the breeding places.

iv) <u>Biting and feeding habits</u> :- Male mosquitoes can not suck blood and normally feed on nectar and plant juices. Female mosquitoes are able to pierce the host skin and feed on blood. The great majority of species are zoophagic i.e. they feed on the blood of mammals, reptiles, birds, and

amphibians but some of the species like *A. fluviatilis* and *A. minimus* have got definite preference for human blood.

v) Flying habits:- Most domestic species of mosquitoes remain in close vicinity of about 1 km. of human or cattles dwellings, however, creeping movement of mosquitoes takes place on account of oviposition, feeding, swarming, mating etc. (Fig : 2)



1.3 Culicine Mosquitoes :- The important human diseases transmitted by culicine mosquitoes are **Filariasis** by *Culex quinquefasciatus* and *Mansonia* species, **Japanese encephalitis** by *Culex vishnui* group and **Dengue/Dengue haemorrhagic fever** by *Aedes* mosquitoes.

i) Habitat:- Culicine mosquitoes prefer dark places and live in human dwellings, cattlesheds and other such shelters. They may also live in outdoor situations in shrubs, grasses, forests etc.

ii) Breeding habits:- Most of the culicine mosquitoes lay their eggs in organically polluted water. The eggs are also laid in unkept drains and unused wells. *Aedes* mosquitoes generally prefer artificial breeding places

such as earthen pots, cement tanks, glass or plastic containers, tyres, coolers, in small collections of water in man made containers. *Mansonia* species breeds in water organically polluted and habouring aquatic plants like Pistia spp., water hyacinth, lemna etc. The larvae and pupae of *Mansonia* mosquitoes remain attached to the roots of these water plants through their respiratory siphon to take oxygen. Eggs are laid on the under surface of leaves of these plants.

iii) Resting habits:- *Culex* and *Aedes* are found in human dwellings or cattlesheds. *Mansonia* species mainly rest in cattlesheds and human dwellings but may also rest outdoor.

iv) Biting and feeding habits:- *Culex* mosquitoes are zoophagous and anthropophagous . *Mansonia* species prefers human blood. Only *Aedes* mosquitoes bite during day time and feed mainly on human blood.

v) Flying habit:- *Culex* and *Mansonia* species of mosquitoes can fly upto a long distance of 4 to 5 kms., while *Aedes* mosquitoes have very limited flight range of about 100 meters and remain near the host. (Fig : 3,4,5)

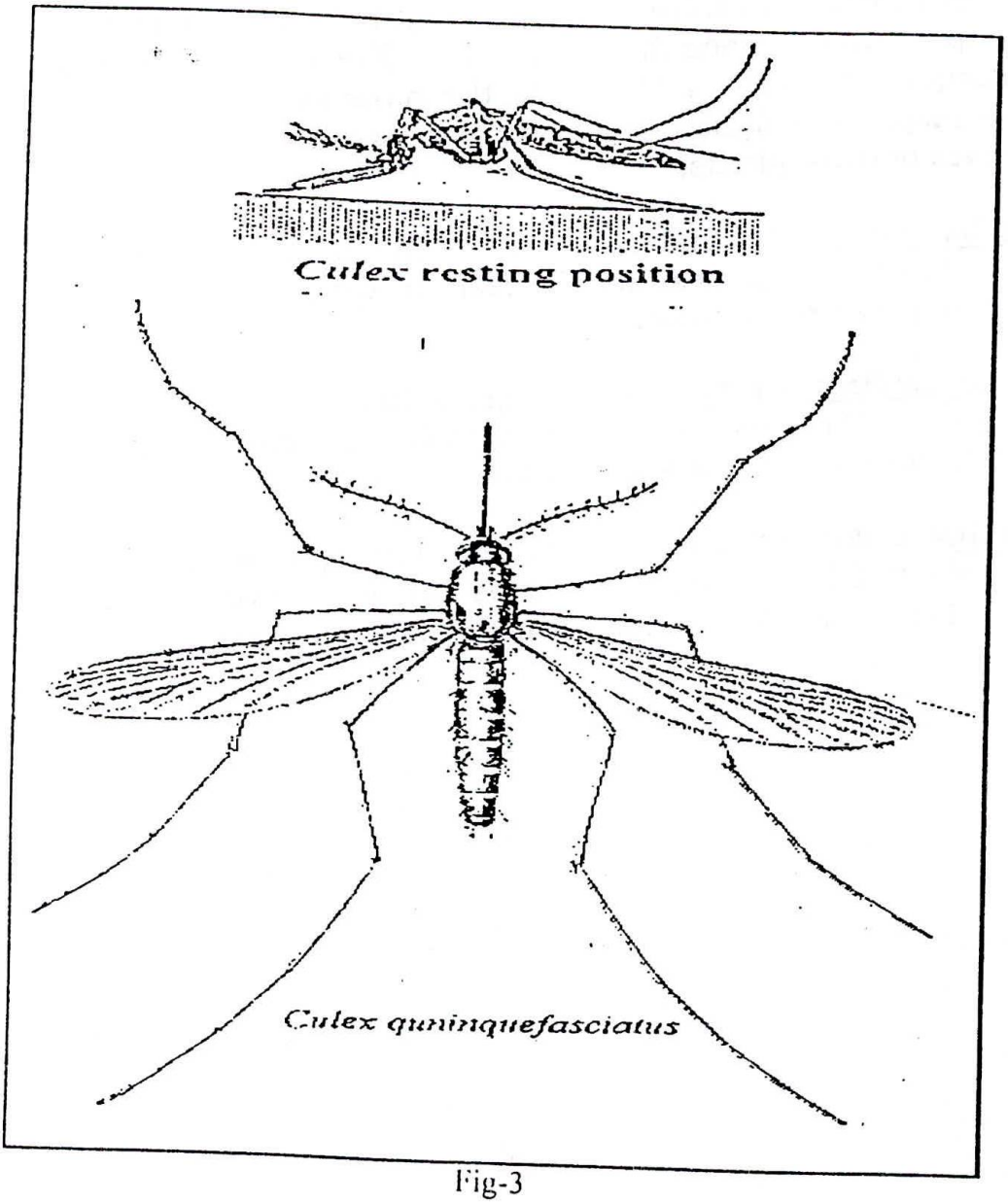


Fig-3

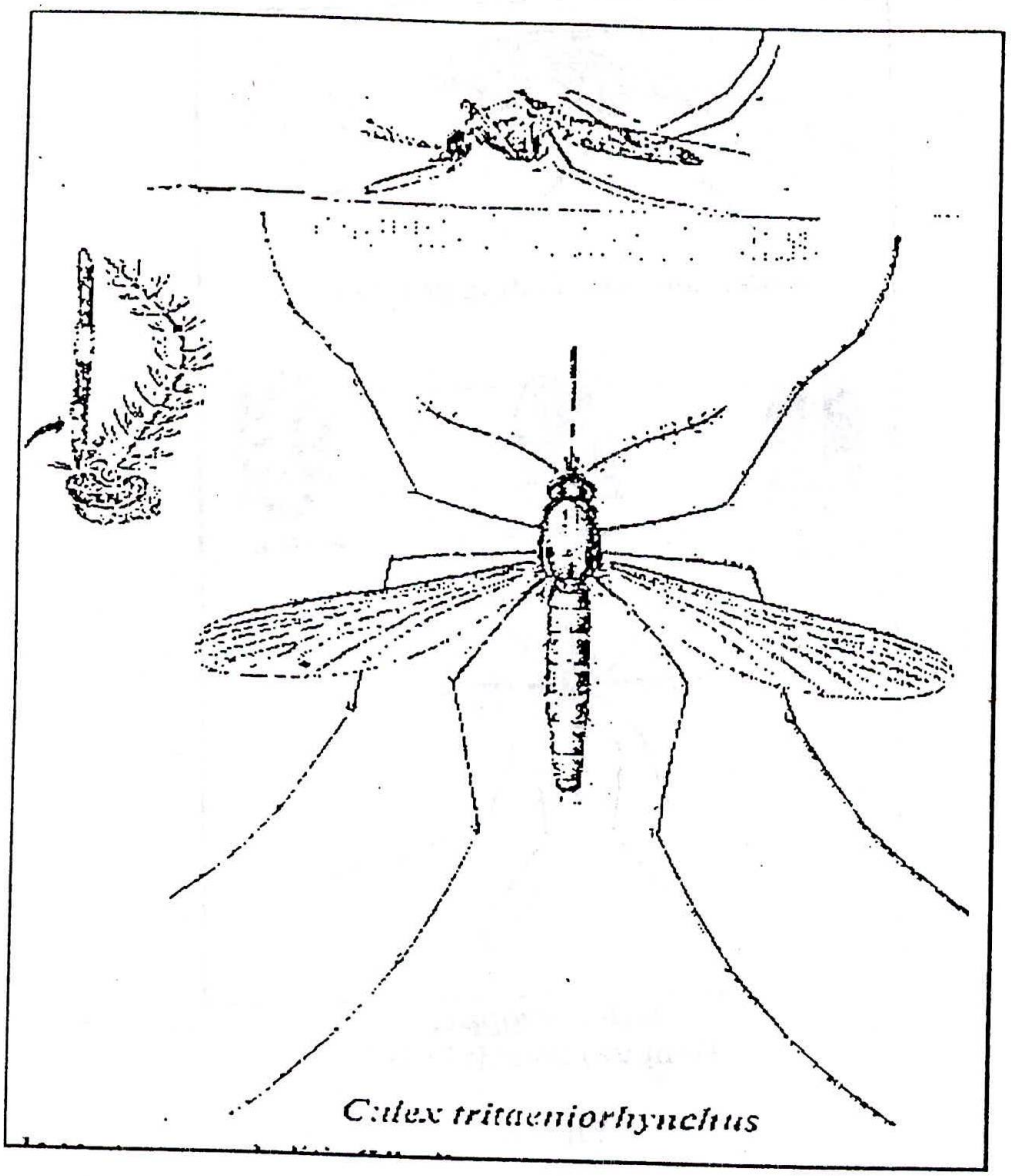
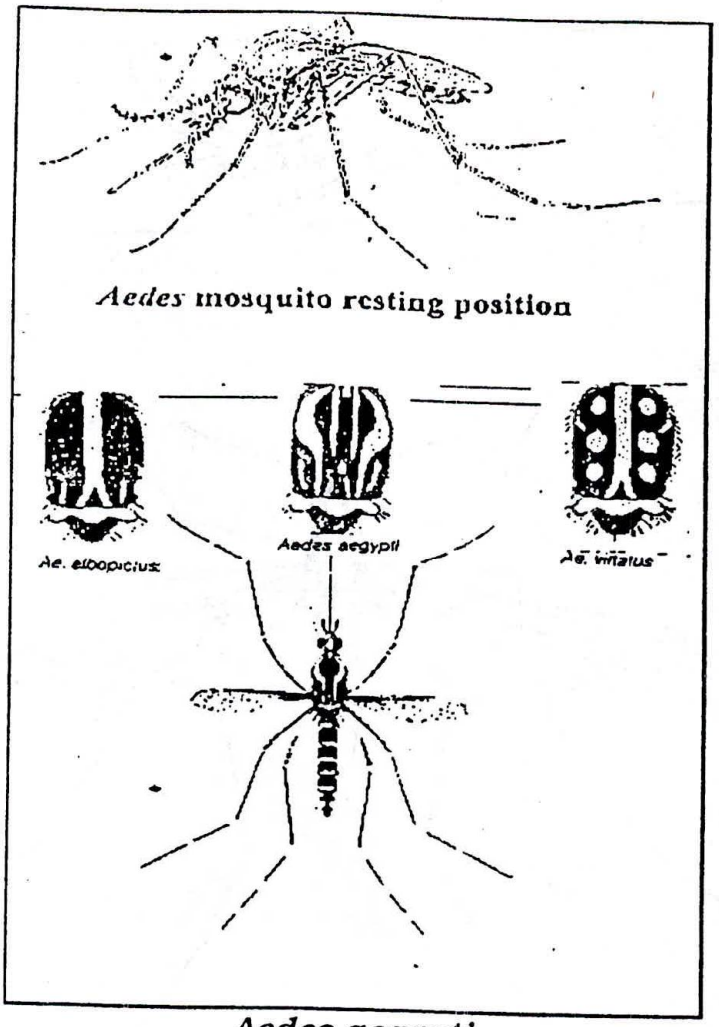


Fig-4

Japanese encephalitis (Viral)

a) Principal vectors — *Cx.tritaenirohynchus, Cx.vishuni and Cx.pseudovishnui*

b) Suspected vectors — *Cx.shitmorei, Cx.epidesmus, Cx.gelidus, A.barbirostris, A.hyrcanus, A.subpictus*



Aedes aegypti
Dengue/DHF (viral)

Fig.- 5

1.4 Life cycle

There are four stages in the life cycle of mosquitoes viz. egg, larva, pupa and adult. The first three stages are aquatic and adult stage is aerial/terrestrial

i) Egg

Anophelines generally lay their eggs singly in clean, oxygenated water. Each egg is boat-shaped in appearance and has distinct float on either side. The number of eggs laid by a single female varies from 40-150.

Culex mosquito lay eggs in the form of egg raft. Each egg raft may contain 150-400 eggs. *C. quinquefasciatus*, vector of filariasis lay eggs in organically polluted water, whereas, *Culex vishnui* group of mosquitoes, vectors of Japanese encephalitis lay egg rafts in the paddy fields, swampy and marshy areas.

The *Aedes* mosquitoes lay eggs in artificial man made containers containing fresh water. The eggs are laid singly and a female may lay 60-150 eggs in one oviposition. The eggs of *Aedes* mosquito can withstand dessication upto 1 year and hatch when containers are inundated with rain water.

The freshly laid eggs are white in colour but within half to one hour of egg laying colour changes to black. The incubation period of egg stage is about 2 days duration under favourable climatic conditions (Tem. 27 C and R.H.- 75-80%) .

ii) Larva

The larva feeds voraciously on minute algae and other plankton present in the water and grows in size. As a result of feeding and growth, the outer skin is shed and next larval stage comes out. There are four larval stages in the life cycle and after third moulting, the larva changes into pupal stage. The larval period last for 6-8 days under favourable climatic conditions.

iii) Pupa

The pupa is coma-shaped in appearance. The head and thorax are fused to form cephalothorax and the abdomen is curved. It is the resting stage in the life cycle and does not take any food. The pupa is very active and sensitive. It moves away, if disturbed. During this stage the future part of the adult mosquito is formed inside the pupa.
The pupal period last for 2 days under favourable climatic conditions.

iv) Adult

The chitinous cuticle of cephalothorax of the pupa breaks in between the respiratory trumphets and through this opening the adult mosquito emerges out. On emergence, the adult mosquito sits on the empty pupal skin or on adjoining vegetations for sometime to harden its body part after which it flies away for mating, feeding and resting.

CHARACTERISTICS OF ANOPHELINES AND CULICINES

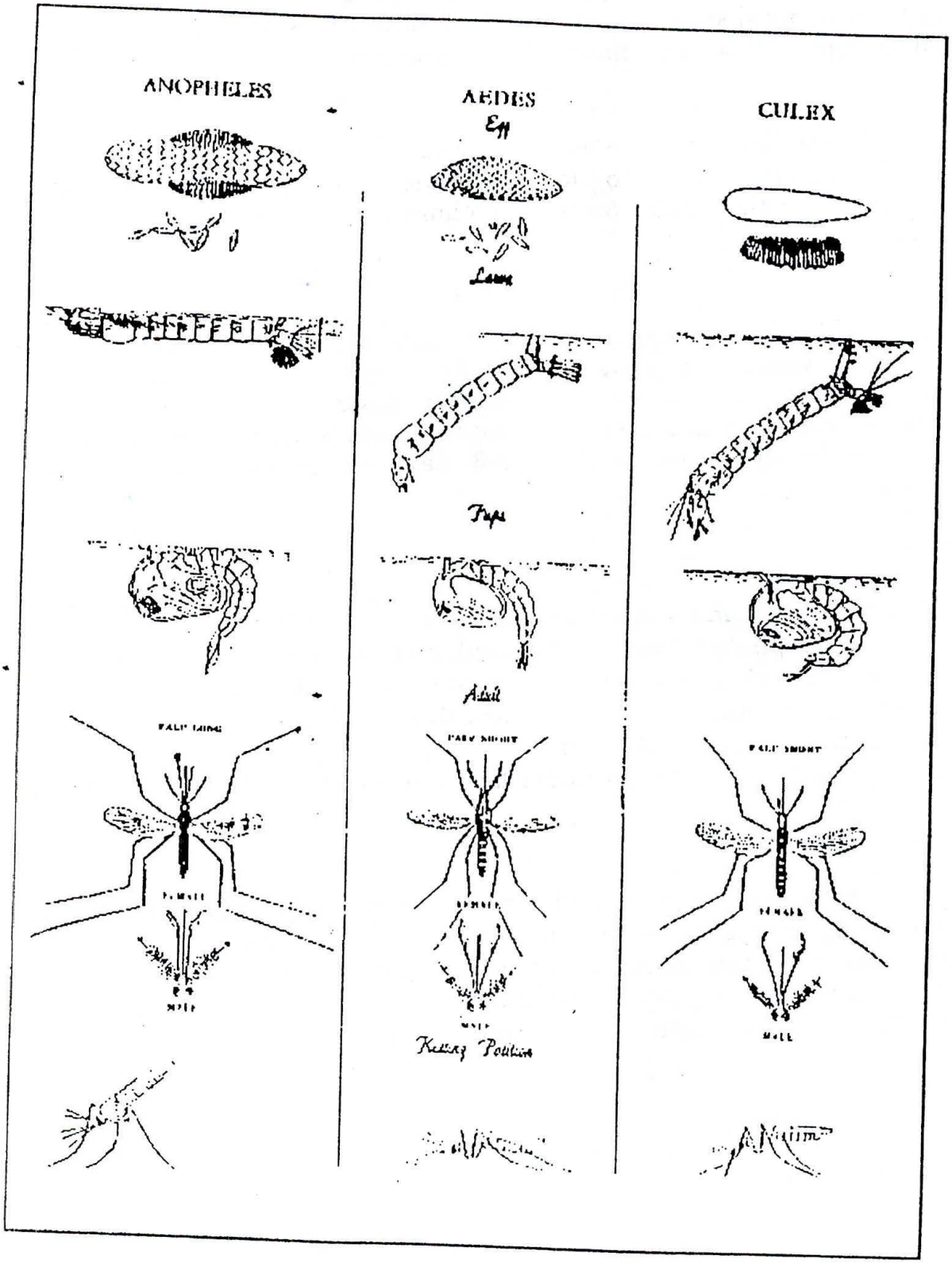


Fig. - 6

b) Larval Density per dip (laddle, larval net, well net) = No. of larvae collected / No. of dips taken

For *Aedes aegypti*

i) Container index - No. of containers found positive x 100 / No. of containers examined

ii) House index - No. of houses found positive x 100 / No. of houses searched

iii) Breteau index - No. of containers found positive x 100 / No. of houses searched

C.) Precauations to be taken while collecting mosquito larvae by dipper

1. The enemel bowl, frying pan, ladle should be immersed in the breeding places at an angle of 45^0. The surface water will flow into the cavity but care should be taken not to fill this completely as otherwise some larvae will be washed out.

2. When the surface of the water is covered with dense floating vegetation or organic debris, the water surface should be agitated to cause the larvae to sink, clear away the vegetation and then wait for 3-5 minutes for larvae to come to the surface once more.

d) Precautions to be taken while using larval net

Larvae may be collected from large stretches of water along the edge of streams, wells and other situations using a larval net of 20-25 cms. diameter. When collecting larvae, the net is held at an angle and skimmed rapidly through the surface near emerging or floating vegetation or pushed along very slowly allowing the surface water to float into the net. Alternatively, the net may be used as a ladle, a series of quick dips being made. The net is inverted and washed out in a bowl of water and the larvae are collected with a pipette.

e) Precautions to be taken while using the well net

The well net is dipped slowly into the well keeping half the border above the water. After waiting 2-3 minutes to allow the disturbed larvae to return to the water surface, the net is dragged slowly and as quietly as possible around the edge of the well keeping the net at the initial depth. When the net has been moved around the border of the well two or three times it is withdrawn and inverted in a white enamel basin containing water. Wait for 2-3 minutes then repeat. The larvae are collected with a pipette .

f) Precautions to be taken while collecting adult mosquitoes in indoor situations

Before collecting mosquitoes from human dwellings, cattle sheds, mixed dwellings etc., one should thoroughly inspect the areas for the presence of snakes, scorpions, centipedes etc. to prevent any mishappening

1.7 Susceptibililty status of vector Mosquitoes

i) Malaria vectors

An. culicifacies and *An. stephensi*, major vectors of malaria are resistant to DDT and HCH in most part of the country. In Maharashtra, Gujarat and certain parts of Haryana triple resistance against DDT, HCH and Malathion has been reported.

The other malaria vectors except *An. annularis* have been reported to be susceptible to conventional insecticides used under NMEP.

ii) Dengue/DHF Vectors

Aedes aegypti mosquito is resistant to DDT and Dieldrin but susceptible to organophosphates and synthetic pyrethroids.

iii) J.E. Vectors

The major J.E. vectors have developed resistance against organochlorine insecticides (DDT, Dieldrin) but are reported to be susceptible to organophosphates and synthetic pyrethroids.

iv) Filariasis Vectors

Cx. quinquefasciatus, vector of Bancroftian filariasis is resistant to most of the organochlorine and organophosphate compounds but susceptible to synthetic pyrethroids.

1.8 Determination of susceptibility test

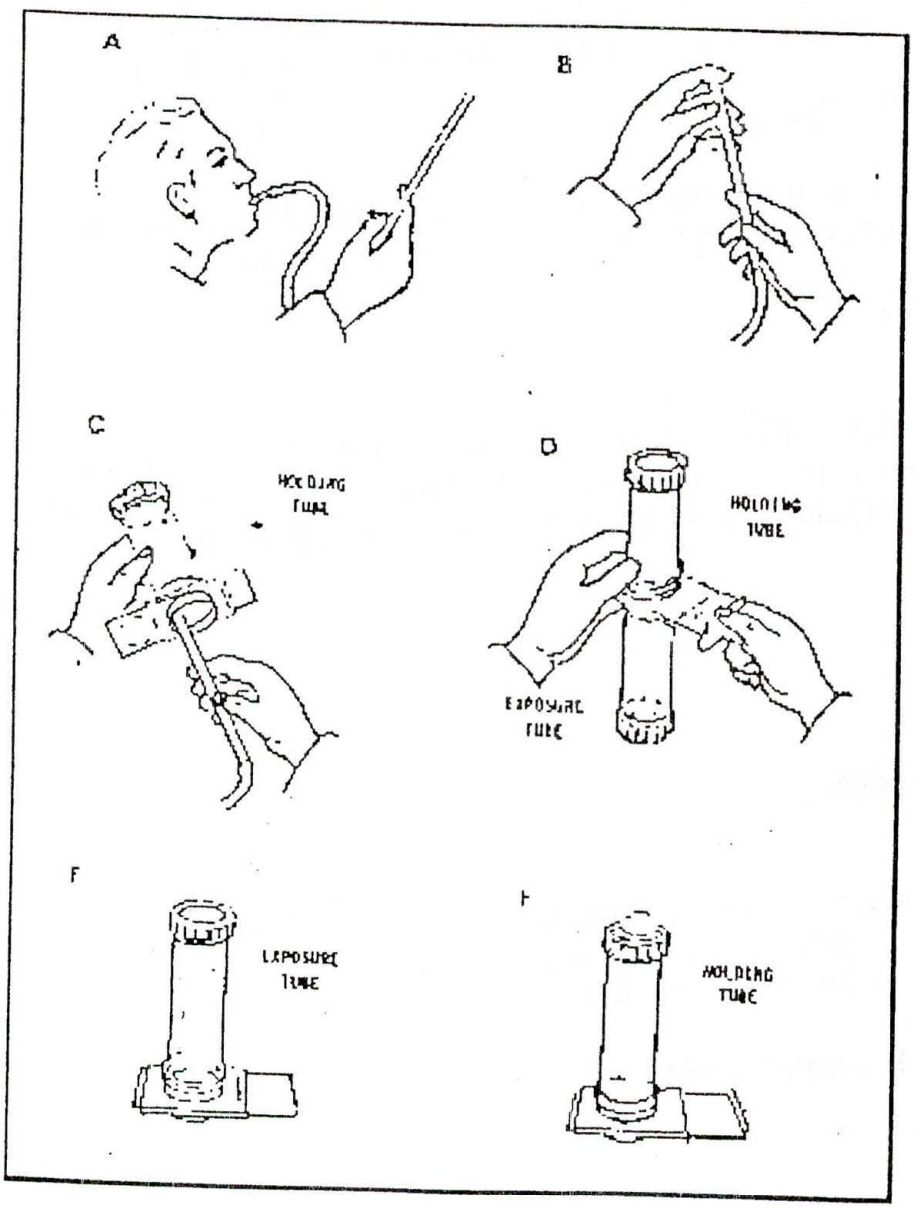
A. Adults

Susceptibility tests of adult mosquitoes are carried out at six monthly interval to ascertain the current susceptibility status of vectors against various insecticides being used under public health programme so that appropriate insecticide may be used for effective vector control.

Freshly fed female mosquitoes collected from the study area are kept under laboratory conditions and the healthy mosquitoes are exposed for a period of one hour and mortality count is made after 24 hrs. as per the WHO method.

Equipments, material and method used to determine the insecticide susceptibililty status of mosquitoes

Equipments/material required:



(Fig:7)

Composition of WHO Test Kit :

(i) - 20 plastic tubes - 125 mm length and 44 mm diameter.

- 8 tubes with red dot - exposure tube
- 2 tubes with green dot - control tube
- 10 tubes with green dot-holding tubes

(ii) - 10 slide-units with a screw cap on either side and provided with a 20 mm filling hole

(iii) - Insecticide impregnated papers

(iv) - Sheet of plain paper for lining of holding tubes

(v) - 20 spring wire clips (8 copper clips for exposure tubes and 12 silver clips for holding and control tubes)

(vi) - Glass aspirator tube

(vii) - Adhesive tape, log probit paper

(viii - Impregnated papers Organochlorine /organphosphate / carbamates /synthetic pyrethroid.

Methodology

- Insert a piece of white paper in each holding tube and put a silver spring wire clip to keep the paper in position.

- Now put 15-25 mosquitoes per tube in each holding tube with the help of sucking tube through filling hole in sliding unit.

- Keep the holding tubes in upright position for 1 hour and damaged mosquitoes should be removed

- In exposure tubes put insecticide impregnated papers of different concentrations and one control paper impregnated with oil (solvent). To keep the paper in position use copper spring wire clip.

- Now transfer mosquitoes in exposure tubes/control tube from holding tubes with the help of sliding unit.

- Leave the exposure tubes standing upright with screen end up for 1 hour

- At the end of exposure period, transfer the mosquitoes to holding tubes. A small cotton pad soaked in glucose should be kept at the top of screen.

- Keep the holding tubes for 24 hours in a place with diffuse light, temperature , 25 + 5^{0}C and R.H. 70-80%.

- Mortality counts are made after 24 hours. For each concentration at least four replicates should be used

- If control mortality is between 5-20 per cent it can be corrected by Abott's formula. The tests with control mortality more than 20 per cent are unsatisfactory and should be repeated.

$$\textbf{Abotts's formula} = \frac{\text{\% test mortality - \% control mortality}}{\text{100 - \% control mortality}} \times 100$$

General Remarks

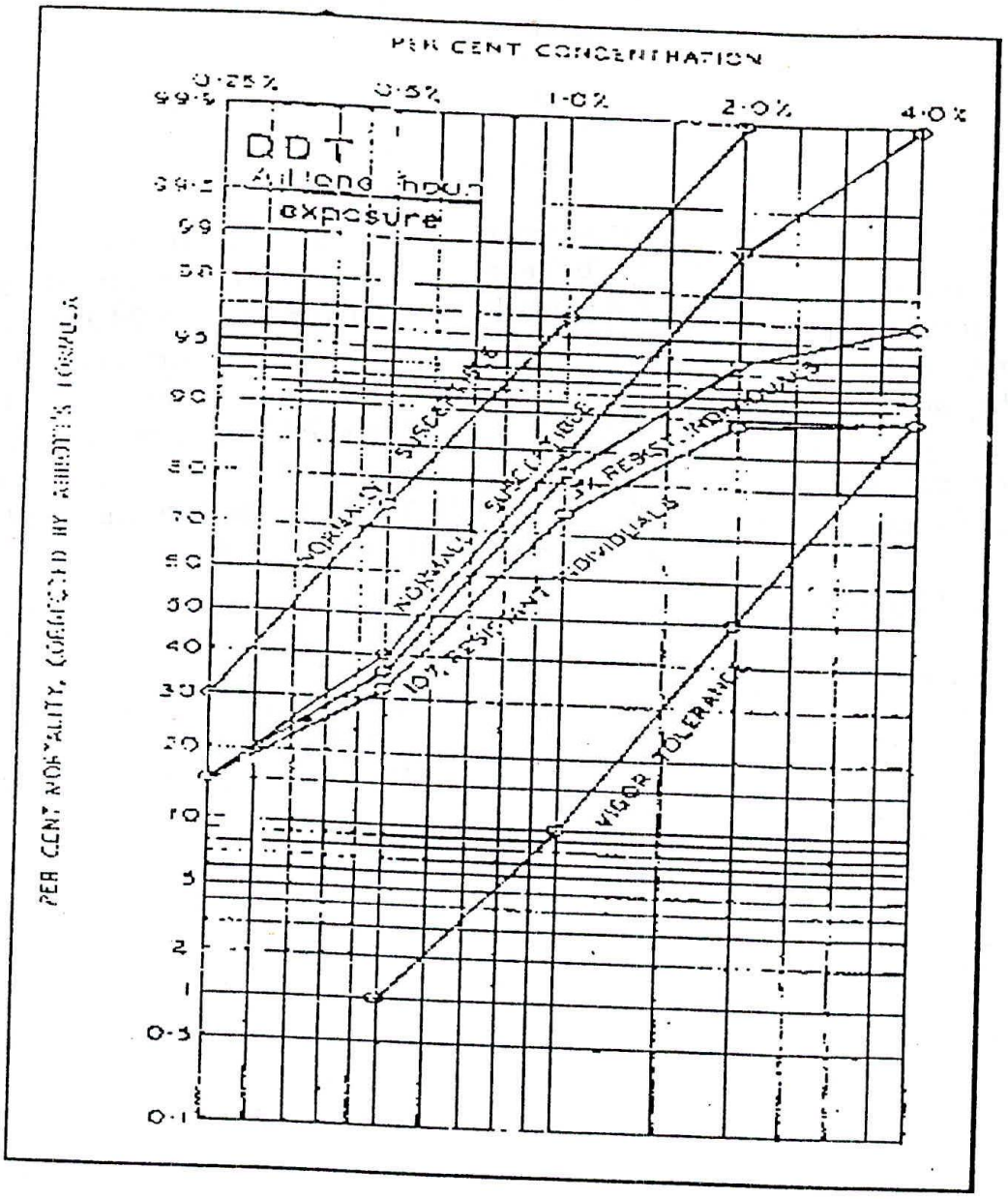
1. Each impregnated paper may be used upto 20 times and upto 3 weeks after removal from the packet

2. After removal of impregnated paper, the packet should be resealed carefully with plastic tape

Result/interpretation

1. Percentage mortality obtained for each concentration can be put in log-probit graph paper.

2. Regression line may be fitted by eyes and LC 50 and LC 95 values can be read from graph.



(Fig. 8)

LARVAE

Susceptibility status of larval population of mosquitoes can be determined by exposing late 3rd or early 4th instar larvae to various insecticide concentration in 500 ml glass beaker for a period of 24 hrs. and thereafter larval mortality is recorded as per the method recommended by WHO using WHO test kit. Based upon the larval mortality, the susceptibility status of larvae against particular insecticide is ascertained.

As per the guide lines the following criteria is used for determining the susceptible or resistant , tolerent status of adults and larvae.

	Range of Mortality	Status
1.	Between 98% - 100%	Susceptible
2.	Between 80% - 98%	Tolerant (Verification required)
3.	Below 80%	Resistance

Proforma of mosquito larval survey

Locality - _____ Date of collection - _____

PER DIP DENSITY IN + VE BREEDING PLACES

	Sullage water drains	Septic Tank	Cesspits	OHT	Cistern/ Barrel	Ornamental Tank	Wells	Irrgn. Canal	Seepage Water	Rice Field	Lake	Rain Water Collcn.	Rejected Tyre Utensil	Others
ANOPHELINES														
L-I-II														
L-II														
PUPA														
CULICINES														
L-I-II														
L-III-IV														
PUPA														
AEDES														
L-I-II														
L-III-IV														
PUPA														

Proforma for Indoor Adult Mosquito Collection Record (MHD)

Distt.

P.H.C. Date

Village. Time

Method: Aspirator.

LastSpray on:

House/ Cattle shed

Weather: Clear/Cloudy/Rainy

S.No.	Mosquito Species	Houses Abdominal Conditions				Total		Density P.M.H. (houses)	Time Spent Cattle Shed Abdominal conditions				Total		Density P.M.H. (Cattle Shed)
		UF	F	SG	G	F	M		UF	F	SG	G	F	M	
1.	Anophelines														
2.	Culicines														
3.	Aedes														

UF = Unfed F = Fed SG = Semigavid G = Gravid

2.Vector Control

The major thrust for the control of vector-borne diseases has to be on vector control, as the elimination of pathogens/parasites in human or zoonotic reservoir of infection is not in the realm of practicability.

The main objectives of vector control is to keep the vector density at low level to minimise vector-reservoir contact and to curtail the longevity of vector species to interrupt disease transmission. Vector control measures are undertaken where population aggregate for the sake of feeding, resting, breeding etc. particularly during the high density period.

2.1 PERSONAL PROTECTION MEASURES

2.1.1 Anti- adult measures

Several personal protection measures are available for providing protection against the mosquito bite. They can be used as supplementary measures in remote and inaccessible areas or against exophilic and endophagic vector species depending upon their feasibility, cost effectiveness and sustainability.

i) **Physical methods**

This include protective clothings, use of bednets, screening of windows/doors etc.

ii) **Repellents** - These are substances applied to the skin, clothings or mosquito net to repel the mosquitoes and prevent them from biting. The most commonly used repellents are DMP (Dimethyl phthalate) and DEET (Diethyl toluamide). They provide protection for 3-4 hours.

iii) **Impregnated bed nets**

Pyrethroids are fast acting, broad spectrum insecticides with low mammalian toxicity. Impregnation of bednet with synthetic pyrethroid enhances its potential for reduction or interruption of disease transmission against endophagic or exophagic species of mosquitoes. Impregnated bed nets produce deterrent, repellent and killing action and help in reducing man mosquito contact.

iv) **Coils**- Mosquito coils containing natural pyrethrum and herbal products are used in many countries for protection from mosquito bites. Use of Tortoise, Rooster brand coils available in the market last 6-7 hours.

v) **Mats** - The mat is impregnated with synthetic pyrethroids viz. Allethrin/bioallethrin and heated on a plate fitted in a small electric device. Mosquitoes are either repelled or knocked down by the vapor action of the pyrethroid. The mats provide protection from mosquito bite for 10-12 hours.

vi) **Indoor residual insecticidal spray**

Selective spraying is recommended against vector mosquito species which predominently rest and feed in indoor situations. Depending upon the susceptibility status of the vector mosquito species to various organochloroine , organophosphate and synthethic pyrethroids. The insecticide is to be chosen to which the local vector is amenable to control. The details about the insecticide, dosage, the formulation and application etc. are given in the Table- 1.

vii) **Space spraying by Mist, Thermal fogging or ULV spray**

Space spraying has been successfully used to control outbreaks of vector-borne diseases such as malaria, dengue, Japanese encephalitis, Western equine encephalitis etc. The space spray is usually undertaken to control the resting population of mosquitoes either by using the natural pyrethrum extract diluted in kerosene oil or malathion during outbreak situations to interrupt the disease transmission by crisis. This is done in the form of mist, thermal fogging or ULV spray . Insecticides formulation and their dosages for space spray are given in Table- 2.

2. **Antilarval measures**

Anti- larval measures are used as an adjunct to other methods of control and are rarely used as main method of control except against container breeding species or against those mosquito species which breed in confined or specific small water bodies such as *Aedes aegypti, An. stephensi* and *An. sundaicus*. Antilarval measures can also be tried in an area where vector species are resistant to commonly used insecticide or exhibit exophily and exophagy or under those situations where adulticide measures are not cost effective or tend to endanger the environment.

Antilarval measures in tropical countries are mainly used in urban or peri urban areas. These measures can be used in certain specialised situations like minning, irrigation wells, tanks etc. if they are operationally feasible and cost effective. The basic idea of all antilarval measures is to prevent, reduce or eliminate the breeding places. Certain commonly used antilarval measures are briefly discussed below:

i) **M.L.O. (Mosquito larvicidal oil)** - Oiling is done in situations where breeding is temporary and permanent measures may not be cost effective. Oiling of a breeding sites kill the larvae by choking their spiracles with oil film & cutting the oxygen supply. It also deter the adult mosquitoes from egg laying.

ii) **Paris green (Copper aceto-arsenite)** - It has been successfully used in malaria control programme for the control of anopheline and culicine breeding. It is applied as dust or granular formulation.

iii) **Abate (Temephos) and Baytex (Fenthion)** - Widely used under urban Malaria Scheme for the control of breeding of anopeheline and culicines mosquitoes . Larvicide formulations and their dosages are given in Table - 3.

2.3 Environmental management for vector control

WHO expert committee on Vector Biology and Control in 1979 defined environmental management as follows:

" The planning, organisation, carrying out and monitoring of activities for modification and/or manipulation of environmental factors of their interaction with man with a view to preventing or minimising vector population and reducing man-vector pathogen control."

This approach which should be carried out prudently and skillfully is naturalistic and involves an attempt to extend and intensify natural factors which limit vector breeding, survival and contact with man. But these measures have many constraints and limitations viz.

i) Selective application,
ii) Require high degree of inter-sectoral coordination,
iii) Capital investment of some of the methods is high,
iv) Maintenance is very essential and
v) Active and sustained community involvement.

This is most simple and dependable method of elimination or prevention of mosquito breeding by identifying the active and potential breeding sites of mosquitoes. Environmental management of vectors are much suited for the vectors of urban malaria and Dengue/DHF as their vectors mainly breed in overhead tanks, coolers and other man made containers in domestic and peridomestic situations.

i) **Drainage**

Different species of mosquitoes are known to be associated with varied type of water bodies. It may be impounded rain water, seepage water, natural water courses or man made water courses etc. These can be eliminated by formulating an effective drainage system which will not permit water stagnation and mosquito breeding.

ii) **Mosquito breeding associated with the construction of Roads/Railways**

High mosquitogenic potential is generated during the construction of roads and railways and most of these breeding places can be eliminated if proper engineering methods are followed. The breeding places includes burrow pits, culverts and quarry pits etc. Such breeding places need special attention by Railway Health Authorities who may use a combination of various vector control measures in an integrated way.

iii) **Irrigation and mosquito breeding**

Engineers should incorporate various engineering devices in consultation with public health experts to include an inbuilt system to drain off the seepage water for its better utilization in agriculture.

2.4 **Biological control** -

The predators, pathogens or parasites may be used for the control of larval breeding. Some of the important biocontrol agents are given below:

i) **Larvivorous fishes**

Of several biological agents, larvivorous fishes are still considered to be the most potential and effective predators for the control of mosquito breeding in unused wells, pools, ponds, lakes, fountains, paddy fields etc. The *Poecilia reticulata* and *Gambusia affinis* are the two most important larvivorous fishes used world over for the control of mosquito breeding. They were introduced in India in 1910 and 1928 respectively and have since been acclimatized in various types of ecological conditions. They are considered to be most important larvivorous fishes for field operation because of their small size, voracious feeder on mosquito larvae, hardiness, agility and adaptability to variety of habitats. The *Poecilia reticulata* commonly known as guppy is a bottom feeder , can tolerate very high degree of pollution. It may be used effectivity for the control of *Culex* breeding whereas *G. affinis* is a surface feeder and prefers to breed in clean oxygenated water and is suitable for the control of anopheline breeding. Fishes can be easily cultured on large scale and require minimum efforts for transportation to any distant place.

ii) **Biocides**-The toxins of certain spore-forming bacteria viz. *Bacillus thuringiensis* variety *israelensis* H14 strain and *Bacillus sphaericus* have recently been shown to hold great promise as a microbial control agent for mosquitoes. These bio-larvicides are host specific, safe to predators and friendly to the environment. Of several indigenous and imported formulations of bio-larvicides, wettable powder formulations of *B. sphaericus* (Spherix) and BTI-H-14 Bactoculicide formulations were found to be highly effective in controlling the larval population of mosquitoes

2.5 Integrated vector control

The integrated vector control may be defined as the application of one or more than one vector control method simultaneously or consequently in a given area to control vector borne diseases. When available options are selected on the basis of epidemiological paradigms, vector behaviour, human behaviour and environmental aspects, it becomes selective vector control. This approach is quite appropriate but requires effective planning, and judicious use of national resources. This requires technical competence, managerial skills and sound understanding of vector and its environment.

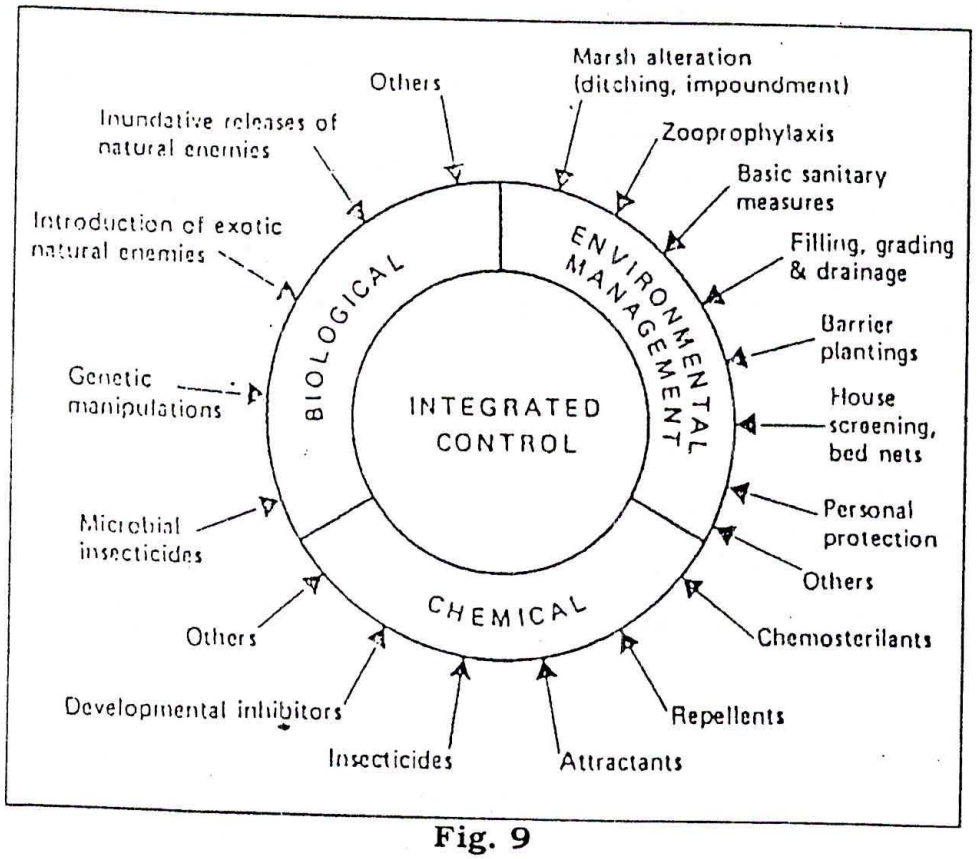


Fig. 9

2.6 Public Health Education and Community participation in the control of vector borne diseases

The role of public health education is vital for the effective imlementation of vector control measures, in respect of vector-borne diseases, as the problem mainly revolves around man and his environment. The aim of the health education for the control of vector-borne diseases like malaria, filariasis, Japanese encephalitis, Dengue/DHF and Kala-azar should be to familiarise and motivate the people by highlighting the following aspects of the disease :

- Causation and mode of disease transmission
- Awareness about the early signs and symptoms of the disease
- Educating the masses to co-operate with the public health workers for the early diagnosis of disease by clinical symptoms and laboratory diagnostic tests
- Usefulness of taking proper and adequate treatment of disease
- Knowledge about the breeding, feeding and resting behaviour of vector species
- Usefulness of insecticidal spray for the control of mosquito/sandfly borne diseases to bring down vector density and to curtail their longevity to interrupt disease transmission
- To restrain local inhabitants from mud plastering of walls of houses, cattlesheds etc. for a minimum period of two months after the spray to retain the residual effect of insecticide for the effective control of mosquitoes and sandflies
- Personal prophylactic measures by using ordinary impregnated bednets or repellents to prevent mosquito/sandfly bite
- To educate masses to sleep on the cots/benches instead of on floor to prevent sandfly or flea bite
- To undertake bio-environment measures to reduce the breeding, resting and feeding places in and around human habitations, cattlesheds etc.
- Use of mass media like radio,television,cinema slides, newspapers, posters and film showsetc. Involvement of Social workers, teachers, school children, public health workers Voluntary Health Organisations/ Resident Welfare Associations should be involved for

disseminating the above given information by holding group meetings or by inter-personal, communication, Health exhibitions etc. to get rid off/ reduce mosquito breeding.

COMMUNITY PARTICIPATION

WHO Alma Ata Declaration (1973) envisaged that community participation should be considered as a crucial component of Primary Health Care (PHC). The idea of community participation was developed with the fond hope that it will make disease control programme more effective. The integration of activities for the control of communicable diseases was considered advantageous to improve the quality of preventive care, reduce morbidity and mortality due to communicable diseases and encourage the participation of people. Involvement of community for the success of any vector control programme assumed still greater significance as the problem revolves mainly around man and his environment. The community will perceive the impact of control measures which will stimulate their active involvement in PHC socially, culturally and technically.

Consequent upon the resurgence of Kala-azar in Bihar in 1977 Plague in Maharashtra and Gujarat in 1994 and Dengue/DHF in Delhi, Haryana and Punjab during 1996, it was observed that the public health education about vector-borne diseases is poor and community participation was practically nil. It is felt that for the control of vector-borne diseases , community may be motivated to co-operate and partcipate for the effective implementation of vector control strategy. After motivation, the community would be able to extend their full co-operation in getting their dwelling units, cattlesheds etc., sprayed with insecticide and should restrain from mud plastering the insecticide treated surface for a minimum period of two months for the retention of residual effect of insecticide. Besides, the community may be motivated to undertake bio-environmental measures like removal of garbage from in and around the houses, pigsties, cattlesheds, filling of all cracks and crevices. The shelters should be made more ventilated and lighted to prevent the breeding, resting and feeding of vector species.

For the success of vector control programme, there has to be a frequent interactions between the health workers and the people so that they may accept the control programme as the " People's Programme" and only this approach will be fruitful for the effective implementation of vector control strategy vis a vis control of vector-borne diseases in various parts of the country.

Activities to be undertaken by various agencies for the control of vector-borne diseases are summarised below:

3. Sandflies - vectors of Visceral and Cutaneous leishmaniasis

Sandflies are mainly involved in the transmission of visceral and cutaneous leishmaniais in various parts of the country. Whereas, visceral leishmaniasis or Kala-azar is transmitted by *Phlebotomus argentipes*, the cutaneous leishmaniasis which is not a major problem in the country is transmitted by *Phlebotomus papatasi, P. salehi and P. sergenti.*

P. argentipes is widely distributed species in India and found in abundance where climate is warm and moist. *P. argentipes* can be identified on the basis of silvery white legs.

P. papatasi is found mainly in plains where climate is hot and dry. It is yellowish brown in colour.

3.1 Morphology of sandfly

Adult sandfly is a small, delicate insect of about 2-3 mm. in length. It is light yellowish to greyish brown in colour with large conspicous dark eyes. The males and females can easily pass through ordinary mosquito net. The body of sandfly is completly covered with long hairs, head bears piercing and sucking type of mouth parts and only female sandfly can sucks the blood whereas males feed on plant saps. They can be easily recognised in nature by the presence of a pair of long and elongated wings which remain erect upward on the body and makes 'V' shaped appearance while resting. The males are identified on the basis of male genitalia at the terminal end of abdomen and females by the presence of spermatheca.

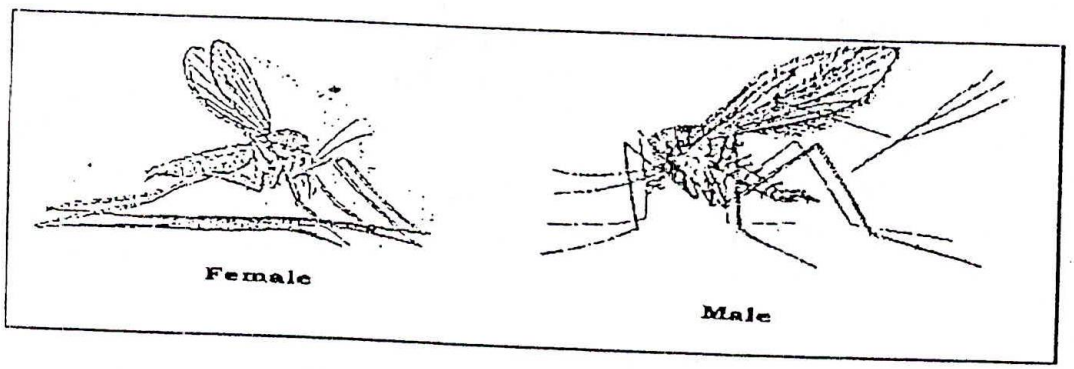


Fig. 10

Life cycle

The life cycle of sandflies is comprised of four stages viz. egg, larva, pupa and adult fig.11.

i) **Egg** - The eggs are laid in moist cracks and crevices containing decaying organic matters. The female *P. argentipes* lay eggs ranging from 5-68 whereas *P. papatasi*, lays eggs ranging from 7-69.

The freshly laid eggs are creamy white in colour, however, their colour changes from dark brown to black after laying. The eggs hatch in about 3-4 days under laboratory conditions at 28 + 2 C and 95% R.H.

ii) **Larva** -The larva is creamy white in colour and possesses a number of hairs on its body. The body is divided into head, thorax and abdomen. After emergence, larvae feed on decaying organic matters. Sandflies have four larval stages. The total larval period of *P. argentipes* and *P. papatasi* was recorded to be 11-29 days and 12-26 days respectively.

iii) **Pupa** - Pupa is elognated and coma- shaped in appearance and is a non-feeding stage. The pupal period varies from 6-10 days for *P. argentipes* and 6-13 days for *P. papatasi* under optimum laboratory conditions.

iv) **Adult** - The adult emerges through a longitudinal slit on the mid-dorsal part of cephalothorax of pupa. Mating in sandflies usually occur on host while feeding but may also takes place after feeding.

Life cycle from egg to emergence of adult was found to be 20-36 days for *P. argentipes* and 22-45 days for *P. papatasi* (Fig.11).

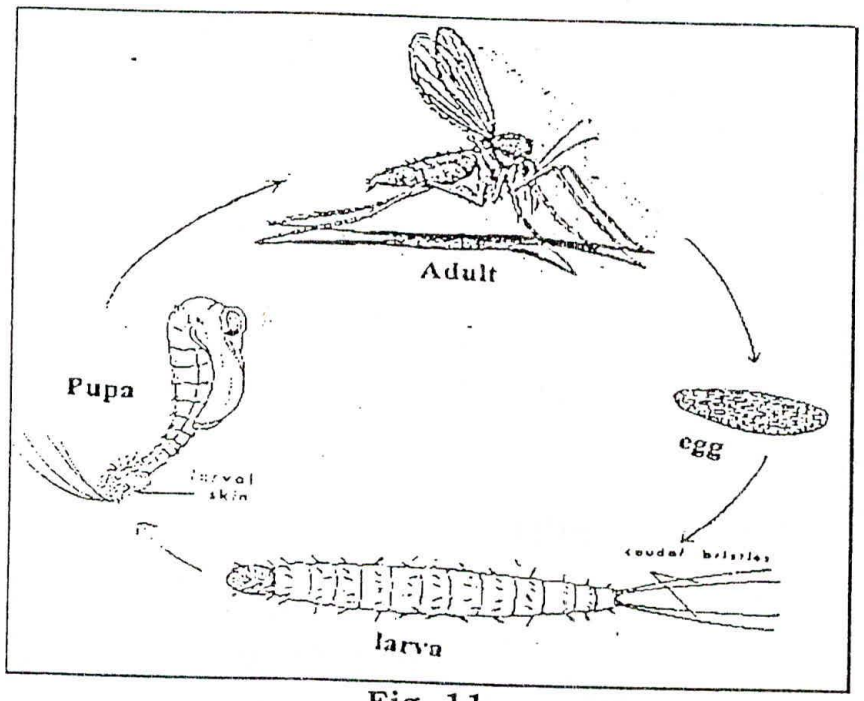


Fig. 11

3.3 Habits and habitats

i) Habits - Sandflies are active during night hours and during day time they remain hidden in cracks, crevices in dark corners of houses and cattlesheds. *P. argentipes* and *P. papatasi* are generally found in mud plastered houses and adjoining cattlesheds.

ii) Feeding habits - Female *Phlebotomus* feed on a varity of mammals at night . *P.argentipes* mainly feed on bovine, whereas *P. papatasi* prefers to feed on human beings.

iii) Resting habits - *P. argentipes* and *P. papatasi* mainly rest in indoor situations in houses, cattlesheds and mixed dwellings etc.

iv) Flight range and movement - Sandflies moves by hopping movements and can not fly long distances. The flight range of *P. argentipes* has been recorded to be 207-505 meters from their breeding places.

v) Longevity - The maximum longevity of *P. argentipes* has been reported to be about 24 days.

vi) Breeding habit - *P. argentipes* lay eggs in the soil having lot of moisture and organic debris in and around cattlesheds and human dwellings.

3.4 Sampling Techniques

Sandflies can be collected by torch light and suction tube method similar to that of mosquitoes. The density of sandflies is expressed in term of Per Man Hour Density (PMHD) (Proforma enclosed)

Other methods of sandfly collections are:

i) Sticky trap method

ii) CDC light traps

iii) Funnel traps

iv) Bait collection

3.5 Susceptibility status to insecticides

P. argentipes, vector of Kala-azar has been reported to be highly susceptible to DDT. However, *P. papatasi* vector of cutaneous leishmaniasis

is highly resistant to DDT and Dieldrin but susceptible to Malathion and other insecticides.

3.6 Control of sandflies -

i) **Prophylatic measures** - use of bed nets and repellents to prevent man/sandfly contact.

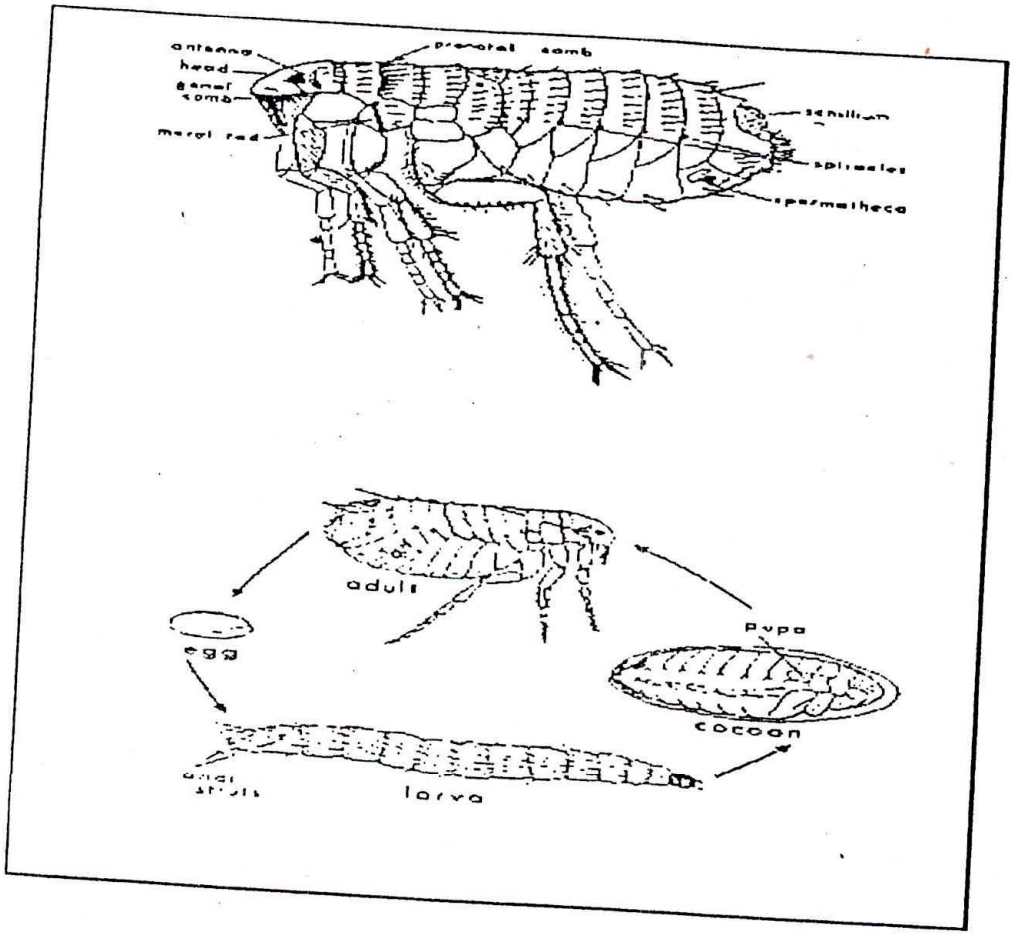
ii) **Environmental measures** - These measures are used to control/eliminate breeding sites of sandflies in and around houses by filling the cracks and crevices.

iii) **Chemical Control** - *P. argentips* can easily be controlled by undertaking residual spray of DDT. Two rounds of indoor residual spraying is undertaken in endemic areas @ 1 gm per sq. meter upto 6 feet height.

4. Rat fleas, vector of plague

Plague which ceased to be the major public health problem in the country during 1966 has resurged in the form of Bubonic plague in Beed Distt. of Maharashtra and pneumonic plague in Surat Distt. of Gujarat during 1994. This has necessiated to intensify disease/vector surveillance to detect plague activity and to monitor flea index in various parts of the country to undertake timely intervention measures.

The Bubonic plague in India is transmitted by three species of fleas namely *Xenopsylla cheopis, X. astia* and *X. brasilensis.* Fleas are laterally compressed insects and their body size varies from 1-4 mm. The body is divided in head, thorax and abdomen and is covered with backwardly directed spines. It has three pair of legs and hind pairs of legs are very well developed and modified for jumping. The mouth parts are of piercing and sucking type and both the sexes suck blood.



4.1 Life cycle - There are four stages in the life cycle of flea viz. egg, larva, pupa and adult. (fig.13).

i) **Eggs** - The eggs are laid in clusters in and around the nest of host animals. It is small in size measuring 0.4 to 0.5 mm. in length, oval in shape and glistering white in appearence when laid but changes to dull yellow colour after few hours of laying. A single *X. cheopis* female may lay

300-400 eggs during its life time. The incubation period of egg is about 2-4 days

ii) **Larva** - The 1st stage larva hatches out from the egg in 2-4 days. Larvae are small, 13 segmented worm like creatures without leg and its body is covered with hairs. It has chewing types of mouth parts and feed on all types of organic debris. There are 3 larval stages which last for 14-16 days. The 3rd stage larva when fully grown empties it's alimentry canal and pupates. The larva spins a loose meshed cocoon of thread around it to which particles of debris adheres.

iii) **Pupa** - Pupa is usually enclosed in a cocoon and emerges into adult after 8-10 days under favourable climatic conditions (Temp. 27C and Relative humidity 80-90%).

iv) **Adult** - After emergence adults usually takes blood meal after 24 hours. Mating usually occurs on host.

4.2 Biology and ecology -

(i) **Habit and habitat** - Fleas are ectoparasites of warm blooded animals specially rodent species. They are generally found on host's body while taking blood or as free living and their immature stages are found inside the rodent burrows.

(ii) **Feeding habit** - Both the sexes feeds on a variety of animals. The female feed for the development of eggs and its survival. Flea species have definite host preference but they can also feed on other hosts also. *X. cheopis* and *X. astia* generally found on rodent species.

(iii) **Resting habit** - After taking blood meal fleas rest in rodent burrows, cracks and crevices having microclimatic condition favourable for the maturation of their eggs.

(iv) **Dispersal/movement** - Fleas move from one place to another by jumping movement. Flea can jump 7 to 8 inches vertically and 14-16 inches horizontally. They can also disperse from one place to another with their animal hosts.

4.3 Sampling Techniques -

Fleas can be collected from the rodents after trapping the rodents using live traps (wire cages) in domestic, peridomestic and sylvatic situations. Traps are laid in evening hours and retrieved in the morning. The positive traps with rodents are to be transported in cloth bags to laboratory and fleas can be collected by combing the rodents. Various indices used for monitoring rodent and flea are given below:

Indices used to determine rodent/flea density

a) Trap positivity rate = $\frac{\text{No. of Traps found +ve for rodents}}{\text{No. of traps laid}} \times 100$

b) Total flea index = $\frac{\text{Total No. of fleas collected}}{\text{Total No. of rodents examined}}$

c) Specific flea index = $\frac{\text{Total No. of fleas collected of a species}}{\text{No. of rodents examined}}$

d) *cheopis* index = $\frac{\text{Total No. of } X.cheopis \text{ collected}}{\text{No. of rodents examined}}$

The *cheopis* index must be kept below 1.0 in plague endemic areas to prevent occurrence of the disease.

Proforma for monitoring rodent/flea population is enclosed.

4.4 Preservation and mounting of fleas - The fleas retrieved from the captured rodents should be preserved in 70% alcohol containing a drop of glycerine. The tubes should be labelled properly giving the following details.

Name of the area -
Date of collection -
Name of host -

i) Mounting procedure

a) Transfer the flea to water for one hour to get rid off 70% alcohol

b) Keep flea material in 10% KOH solution at room temperature for one to two days till the specimen become yellowish transparent

c) Keep material in water for few minutes

d) Transfer to 5% aqueous solution of glacial acitic acid for 30 minutes

e) Transfer to water for an hour with several changes

a) Permanent mounting

(i) After step (e) pass the fleas through 50%, 70% and 90% alcohol for dehydration, thereafter, treat with absolute alcohol for one hour

(ii) Clear the specimens in clove oil for few hours, preferably for a day

(ii) Keep the flea material in xylol for 10 minutes

(iv) Mount flea specimen in Canada balsam

(b) Temporary mounting

After step (e) fleas can be directly mounted in a drop of Hoyer's medium and can be dried over hot plate

Hoyer's medium

Distilled water - 50 ml
Gum arabic - 30 gms
Chloral hydrate - 200 gms
Glycerine - 20 ml

4.5 Susceptibility Tests of fleas to insecticides -

Determination of susceptibility tests of fleas to various insecticides is a pre-requisite for undertaking effective vector control measures. Susceptibility test could be under taken as per standard WHO method (WHO Tech. Report Series No. 443). In this method fleas are exposed to the insecticides impregnated filter paper strips in test tubes for a period of one hour and percentage mortality are observed after 24 hours of exposure.

4.6 Current insecticide susceptibility status of flea

Recent studies carried out on the susceptibility status of *Xenopsylla cheopis* from Distt. Beed(Maharashtra), Varanasi (Uttar Pradesh) and Delhi shows that the species is highly resistant to DDT & HCH but susceptible to Malathion and Deltamethrin.

4.7 Control of fleas

The flea population can be controlled by the application of appropriate insecticide as dusting powder. The main sites of treatment are rodent burrows and run ways. The houses and other structures, the bottom of all walls and the floor for an area of about 15-30 cms from wall should be treated with the dust formulation. Dust should also be applied on the top of the wall and along the rafters where rat runways are present. Other rodent habitats such as piles of wood, debris, wooden structures etc. should also be treated with the insecticide dust.

Keeping in view that the vector flea species are resistant to DDT and BHC the other insecticides like Malathion (5.0 %), Deltamethrin (0.005%) and Permethrin (0.5 %) dust can be used for the control of rat fleas.

Application

For the application of dust the hand operated dusters are quite useful. The rodent frequented sites should be thoroughly covered with dust. To control fleas on wild rodents about 30 gms of the dust formulation is sufficient for each burrow.

Proforma for surveillance of rodent/flea population

Area visited -

Date of visit -

No. of Traps laid -

No. of traps +ve -

Traps positivity -

Total No. of rats trapped/Rodent species -

Total No. of Flea retrieved/ Flea index -

No. of sera samples collected -

No. of tissue smears of heart, lung, liver and spleen collected -

No. of tissues taken for culture -

Proforma for Indoor Sand fly Collection

Name of Distt. _____ PHC_____

Village _____ Date of Collection _____

S.No			Sandfly Species Collected													
	Time Spent	Habitat	*P. argentipes*				*P.papatasi*				*Sergentomyia sp.*				Insecticide Spray Status	Remark
			M	F	T	DPMH	M	F	T	DPMH	M	F	T	DPMH		
1.																
2.																
3.																
4.																
5.																
6.																
7.																
8.																
9.																
10.																
11.																
12.																
13.																

Mosquito Control measures which may be undertaken by Individuals and Community

Type of activity	Individual action	Community action
Reduction of Man: Mosquito contact	i) Screening of houses/bedrooms ii) Use of protective clothings to prevent mosquito bites iii) Use of repellents to prevent mosquito bites iv) Use of ordinary or insecticide impregnated mosquito nets	i) Site selection of houses in the villages ii) Deforestation and clearance of vegetations near the dwellings (specific to *An.. dirus* vector of malaria in North East India. iii) Vector deviation by shifting of cattlesheds/ piggeries away from human dwellings (specific to zoophilic anophelines/ culicines) iv) Wire meshing of vent pipes of septic tanks to prevent emergence of and oviposition by adults (specific to *Cx. quinquefasciatus*)
Destruction of adult mosquitoes	i) Use of adulticides or aerosols available in the market	i) Indoor residual spraying of chemical insecticides ii) Thermal or cold fogging (ULV)
Destruction of larvae	i) Emptying water containers periodically, scrubbing and cleaning (specific to *Ae. aegypti*). ii) Use of temephos sand granules for water containers (specific to *Ae. aegypti*) & *A. stephensi* iii) Refrain from throwing garbage into the drains and drain cleaning (specific to *Cx. quinquefasciatus*)	i) Larviciding ii) Rearing and release of larvivorous fish viz. *G.affinis* & *P.reticulata* iii) Flushing of drains and their periodic cleaning iv) Removal of algae and other water plants from the ponds to prevent breeding of vectors of malaria and Japanese encephalitis
Source reduction and Source alteration	i) Proper disposal of unused containers, tyres etc. ii) Covering water containers iii) Filling up of breeding sites	i) Community cleaning-up campaign to remove trash and water-retaining debris for *Aedes* control ii) Installation of proper latrines, drainage and water supply to prevent the breeding of *C. quinquefasciatus* iii) Intermittent irrigation of rice-fields for J.E. vector control iv) Filling up of low lying areas or pumping out of water for malaria/filaria vector control v) Reclamation of land

Plan of action for control of DF/DHF vectors in urban and Rural areas

Control Methods	Expected Agencies	Activities Expected	Ways and Means
Source reduction methods for larval control	Community	I) Remove/reduce non-essential water containers conducive for mosquito breeding	i) Health education
			ii) Mass media (Radio, TV, Film shows, N papers etc.)
		ii) Protect water containers from larval breeding by providing lids or cover	iii) School children/housewives healt m ation
			iv) Volunteers
			v) PHC workers
			vi) Community leaders
	Government	1.Solid waste management to prevent mosquito breeding	I) To set up a core working committee for inter-and intera-sectoral coordination
		2. Provision for reliable piped water	
		3. Legislative measures	
		4. Monitoring and assessment	