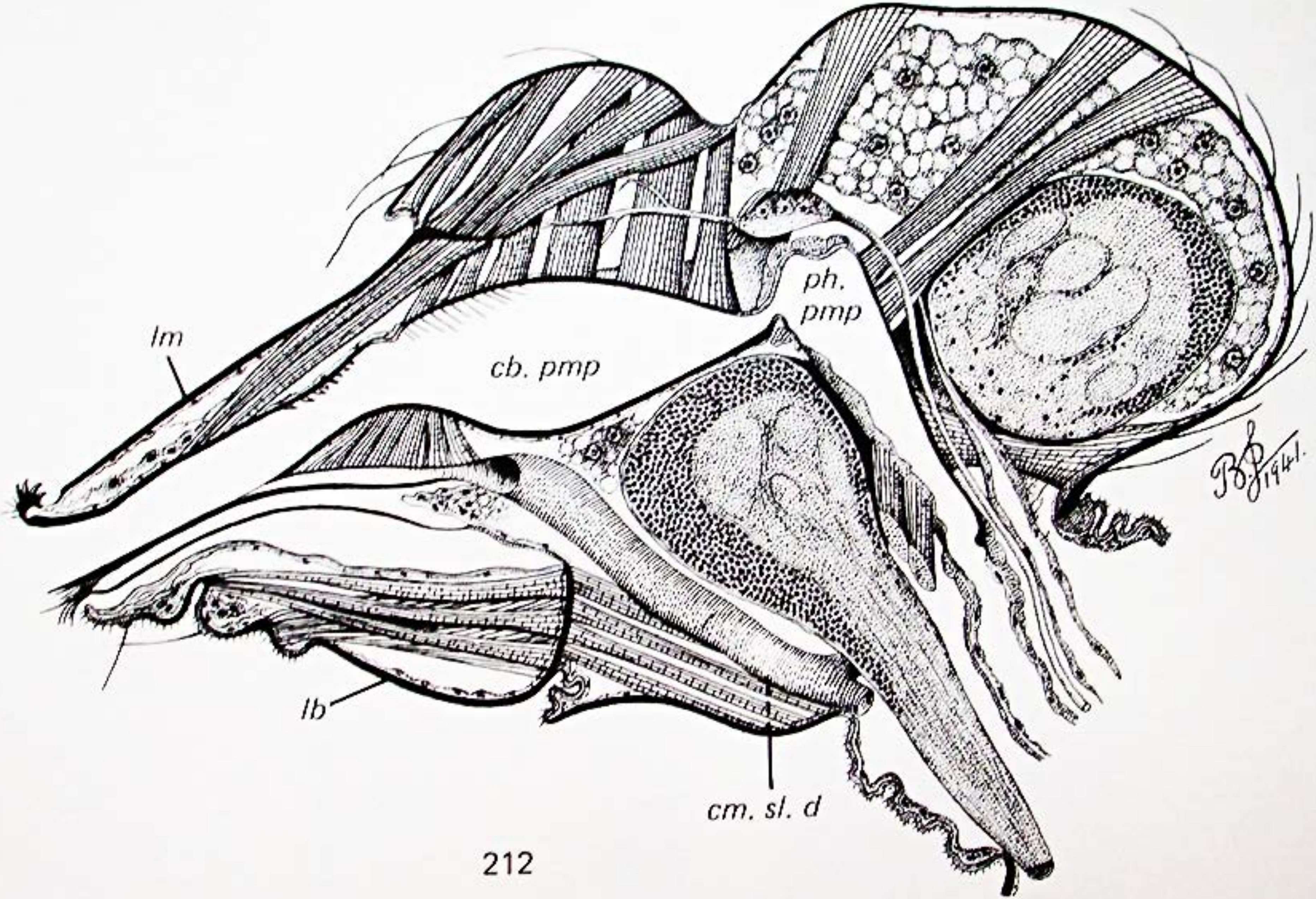
What Can Black Flies Teach us about Hydrodynamics and Filtering Fans?

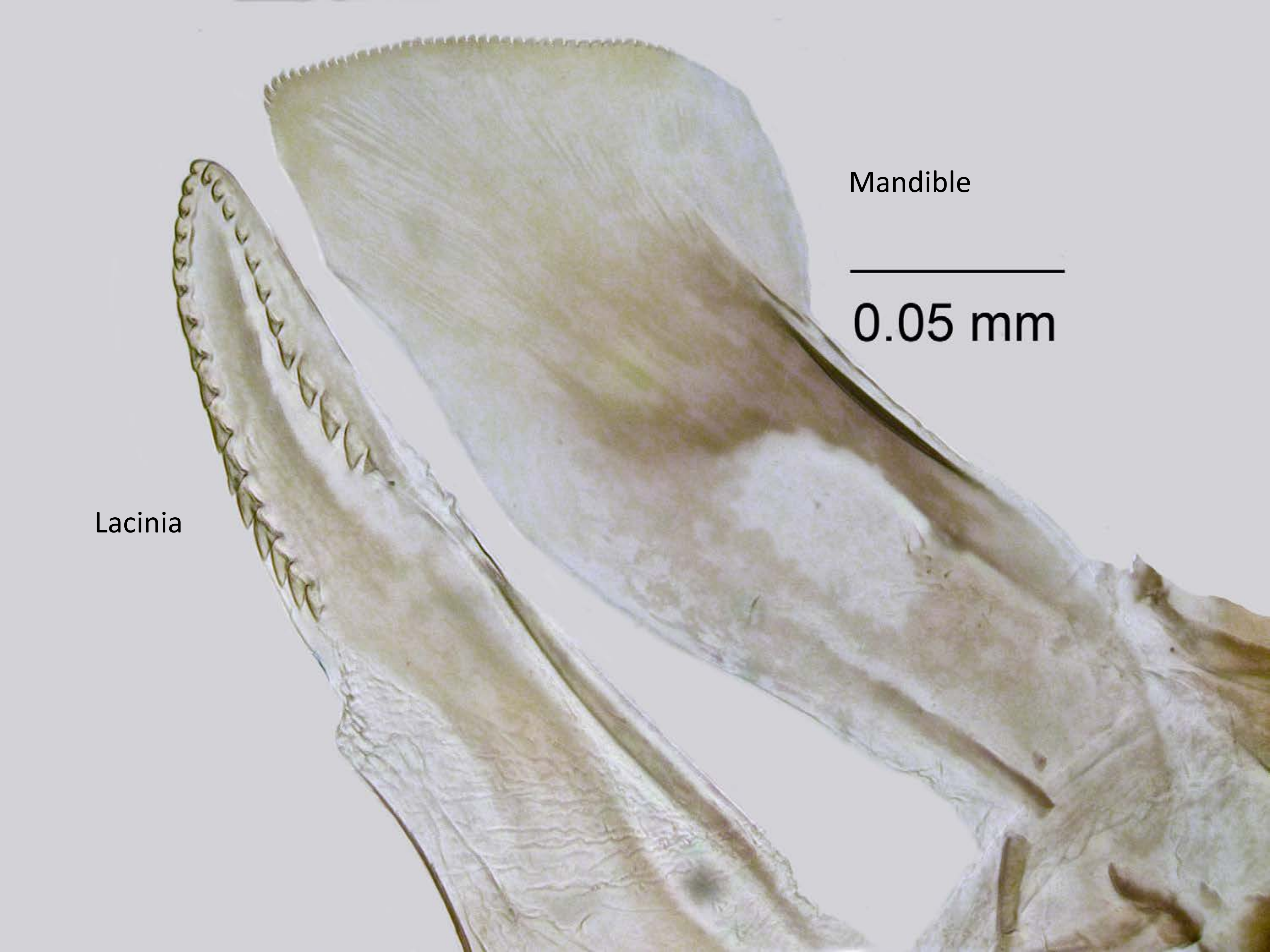
Insects did it first:
with **emphasis** on
Black Flies

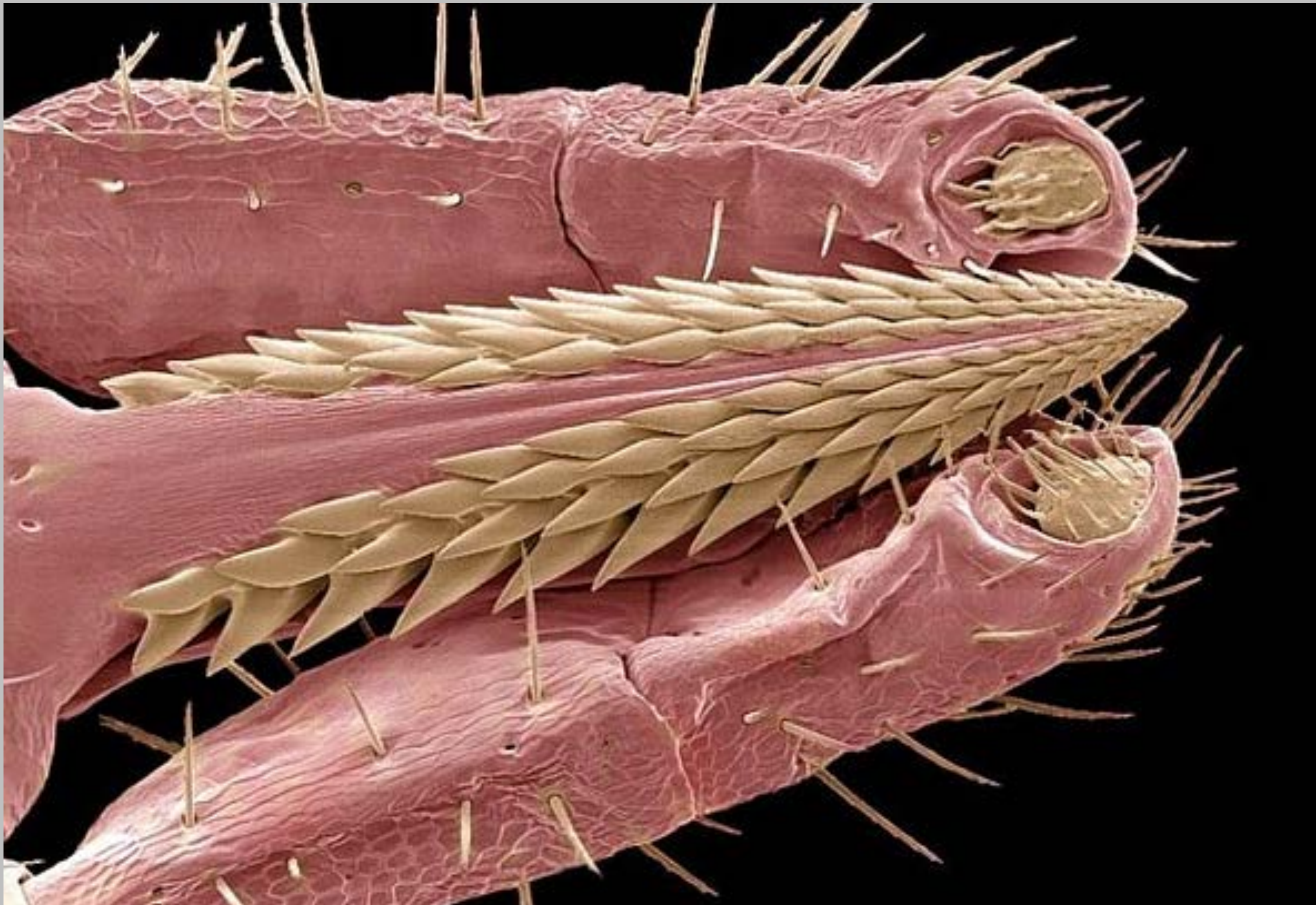
How do engineers do it differently?

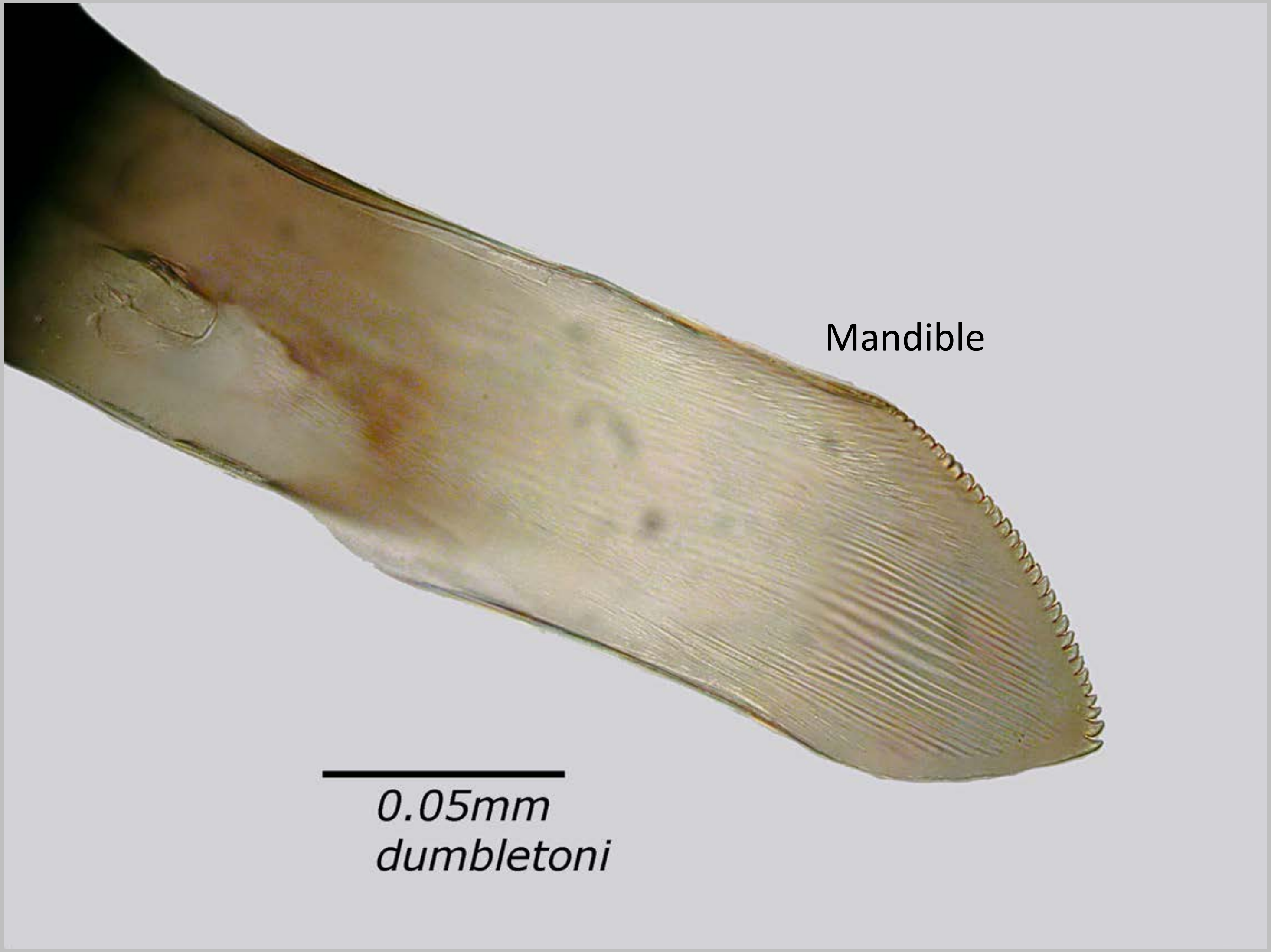


212

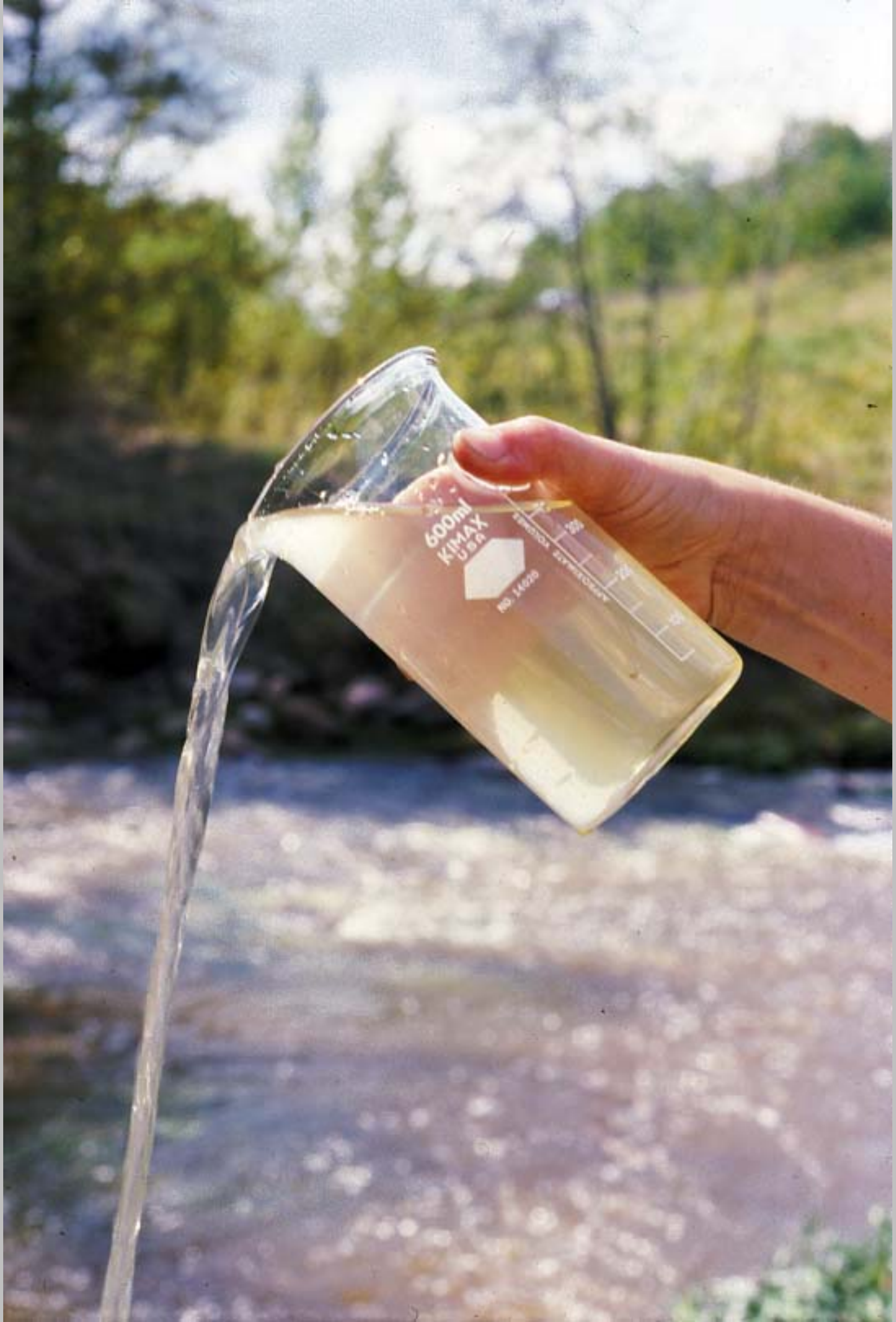

GUZZLER™


Mandible
0.05 mm
Lacinia

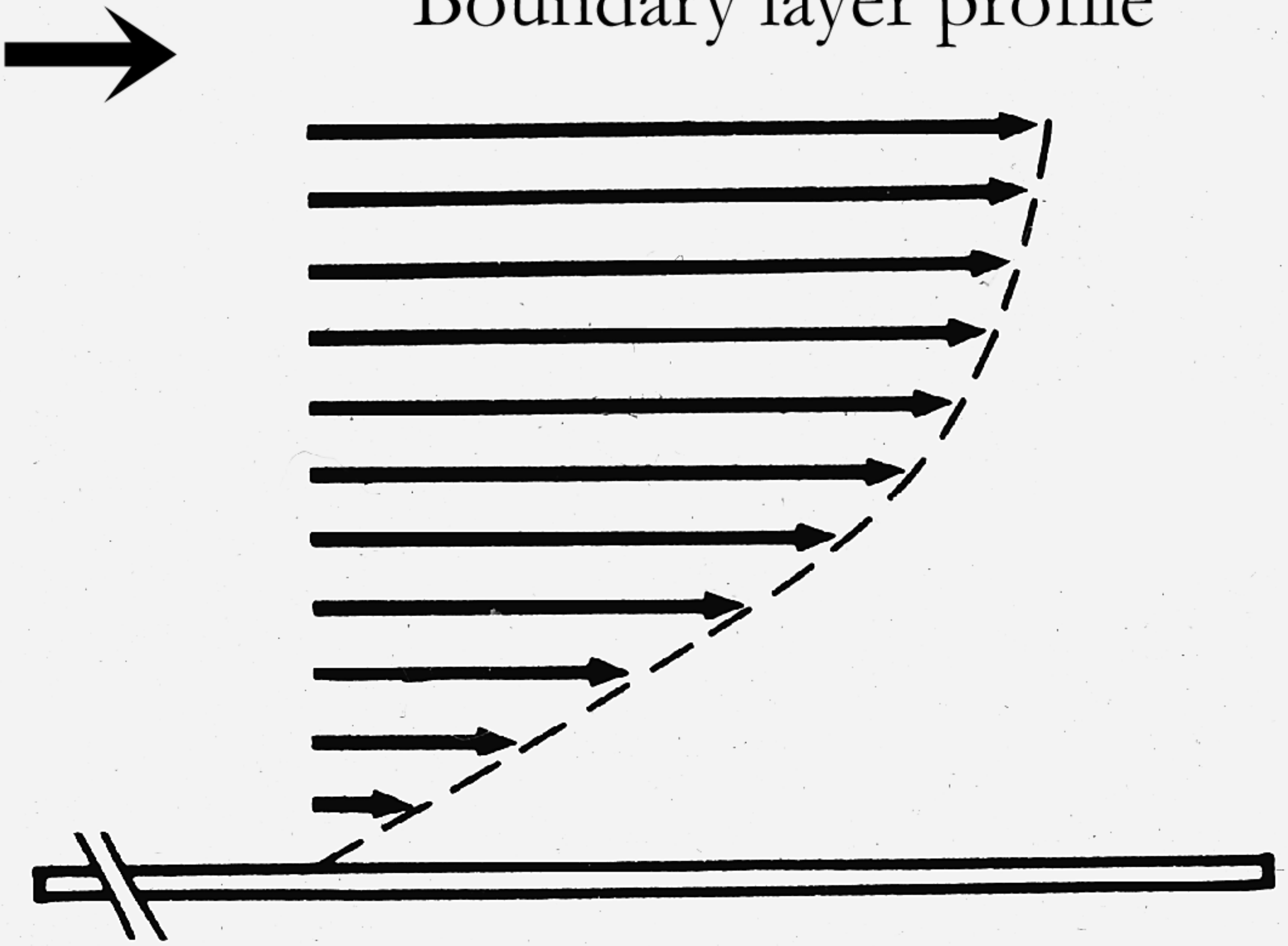


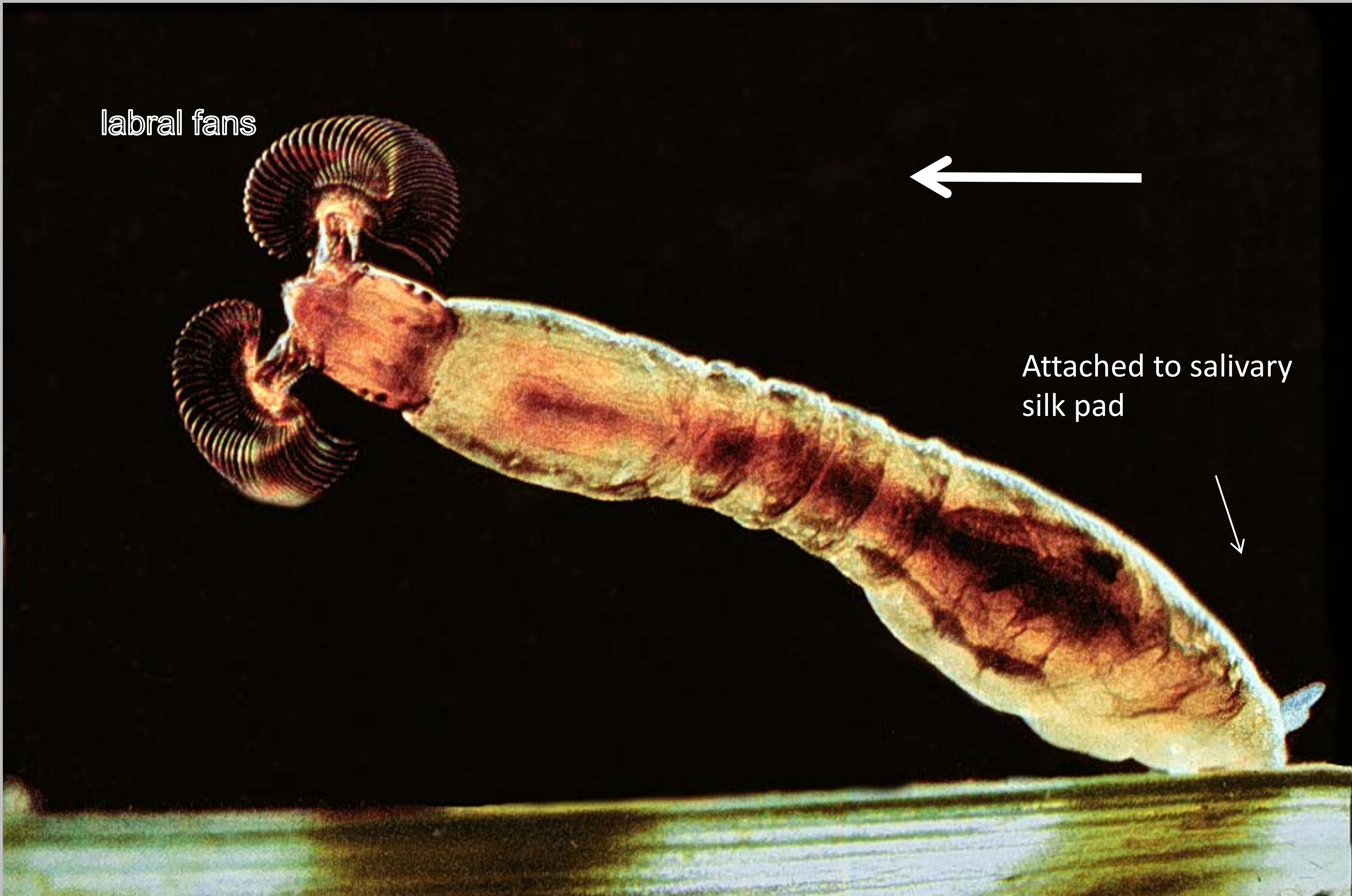

Mandible
0.05mm
dumbletoni

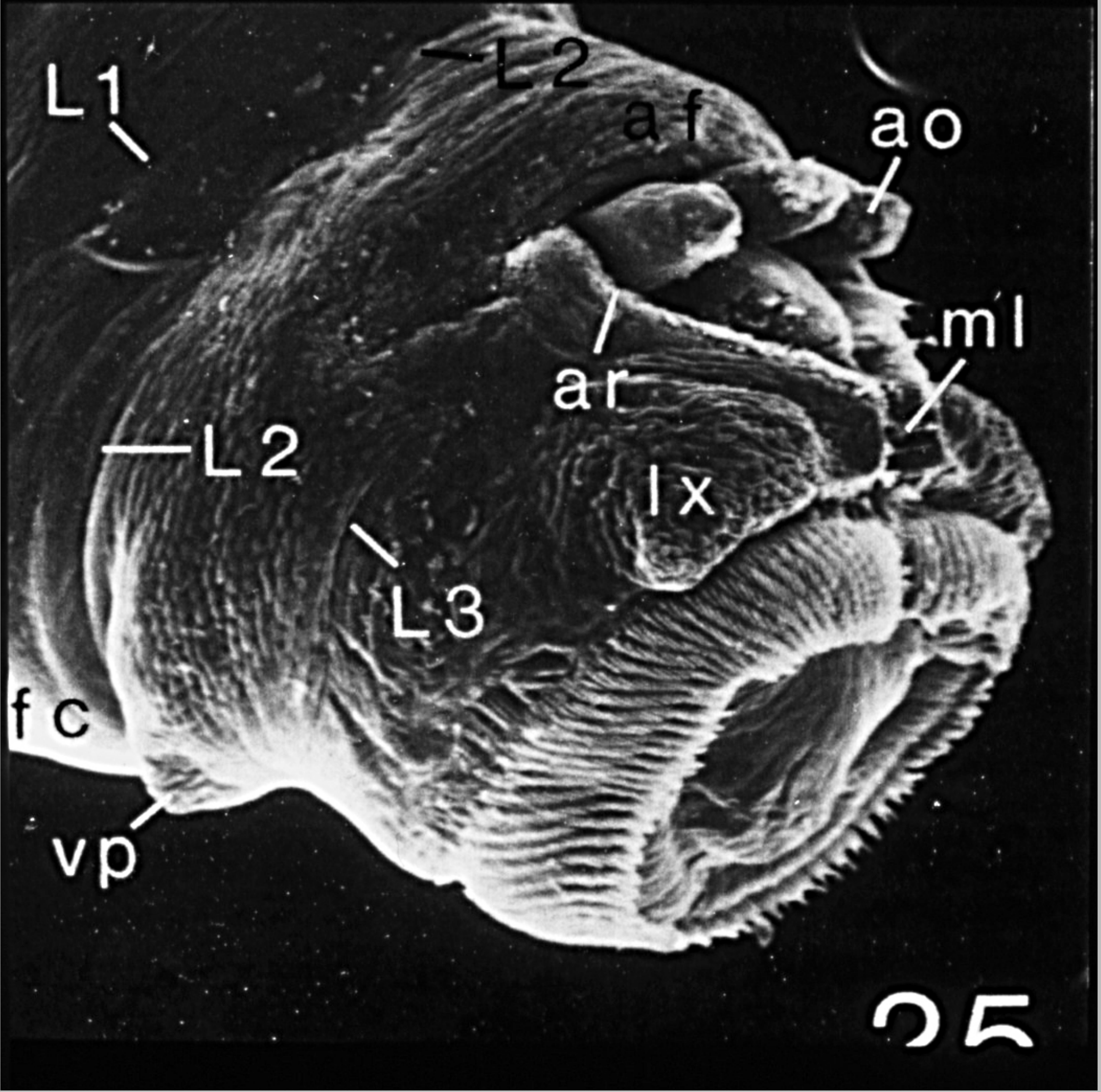

600ml

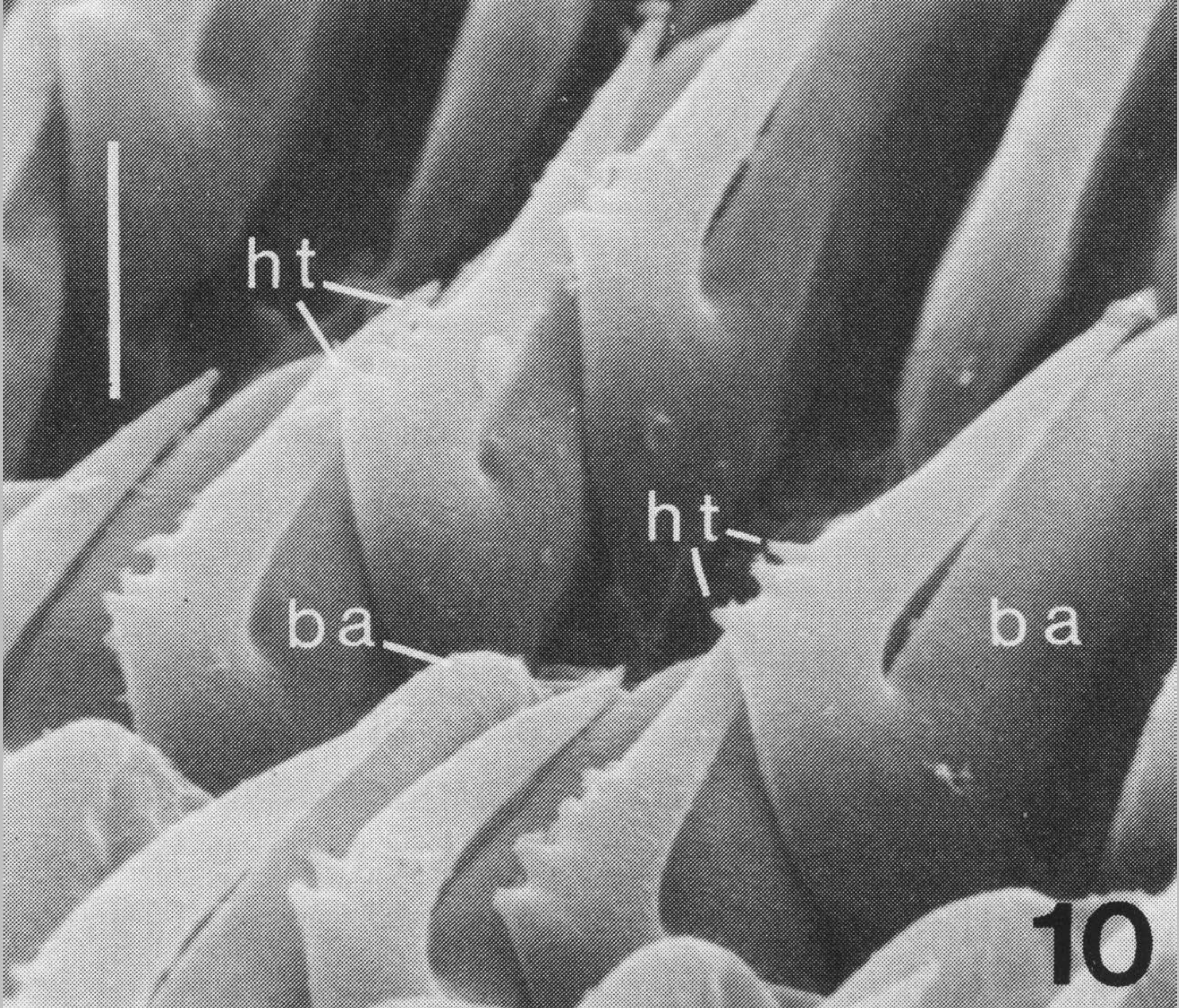

600ml
KIMAX

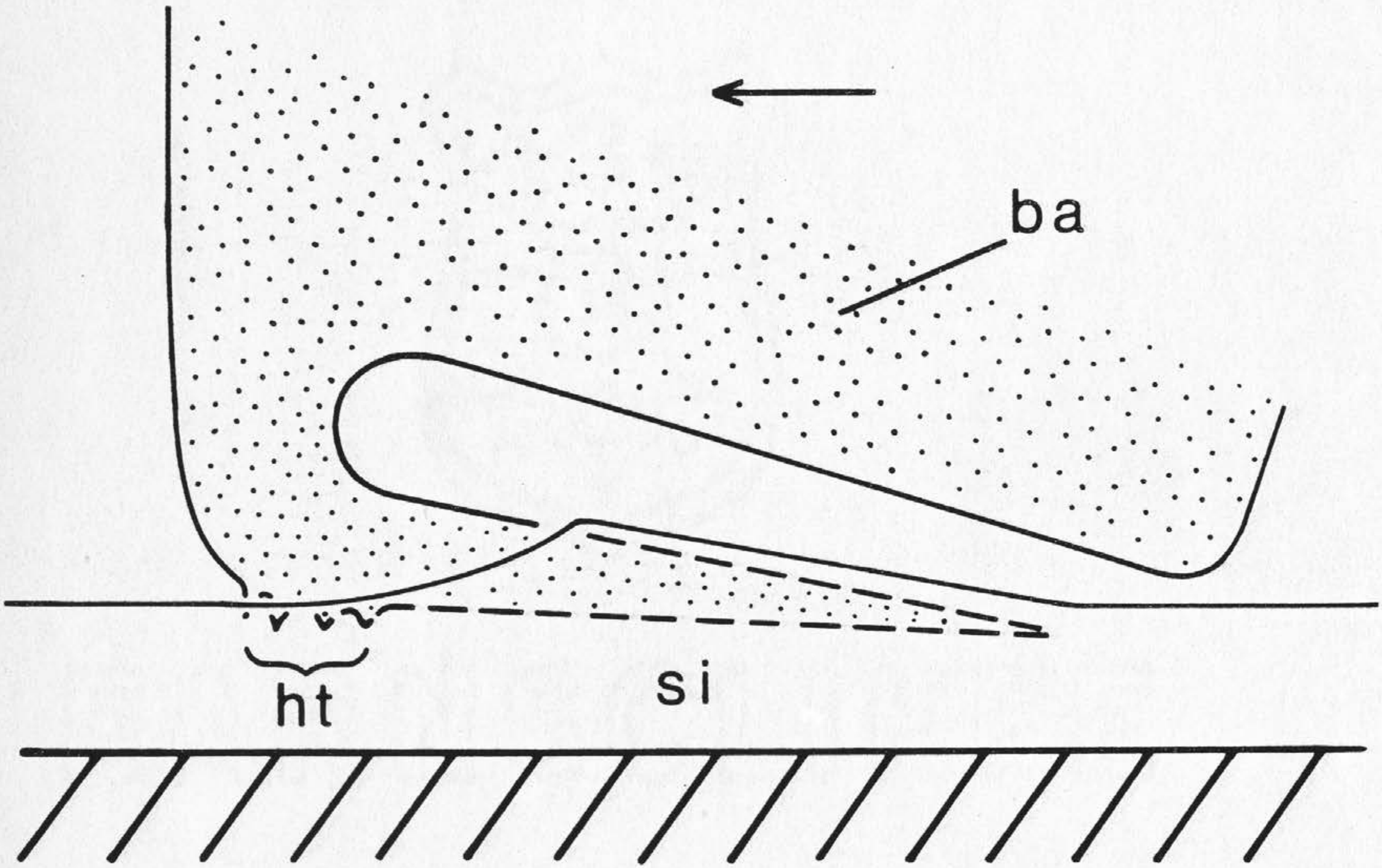
Boundary layer profile




labral fans
Attached to salivary
silk pad


L1
L2
af
ao
ml
ar
L2
lx
L3
fc
vp
25


ht
ht
ba
ba
10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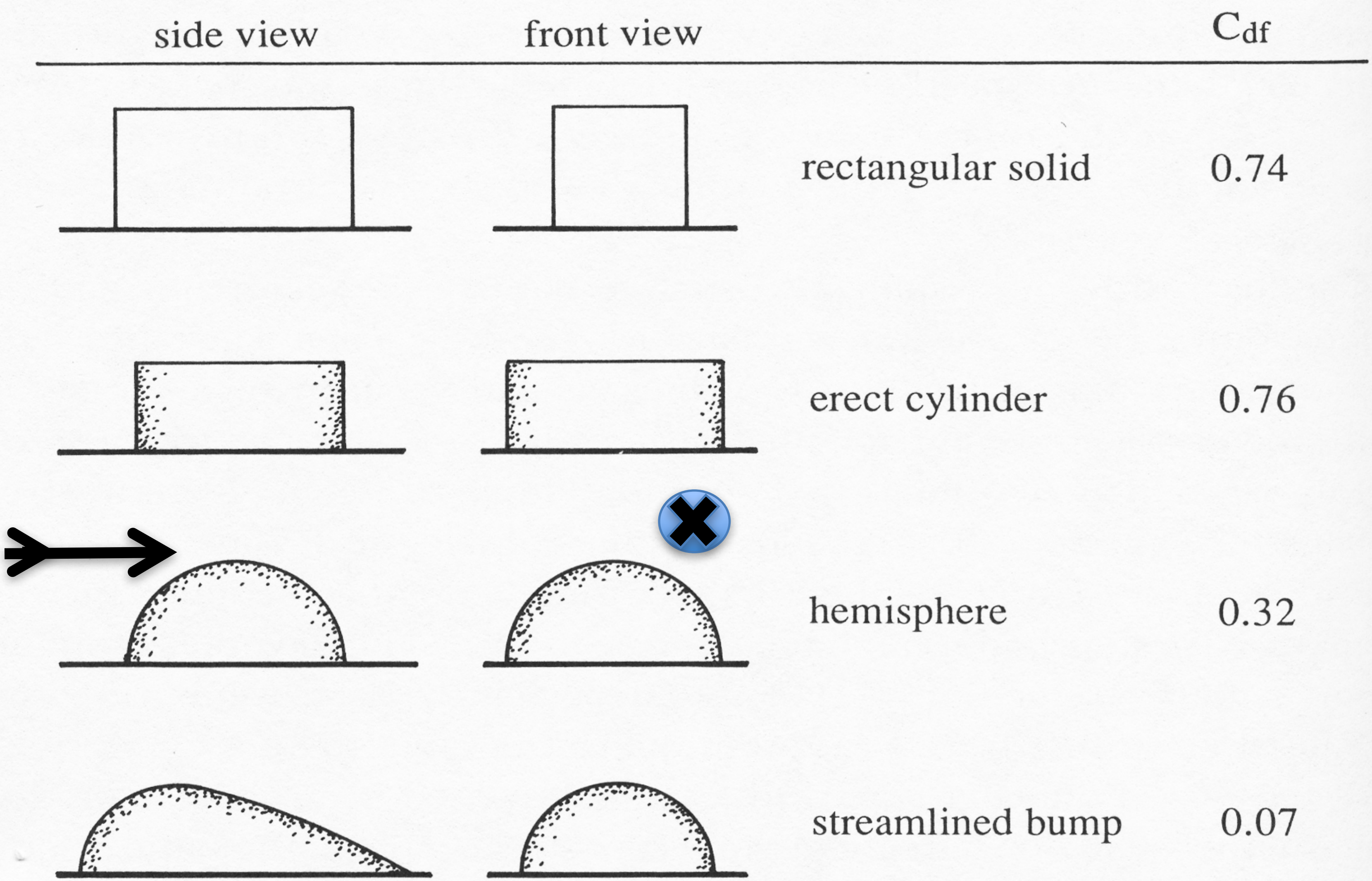
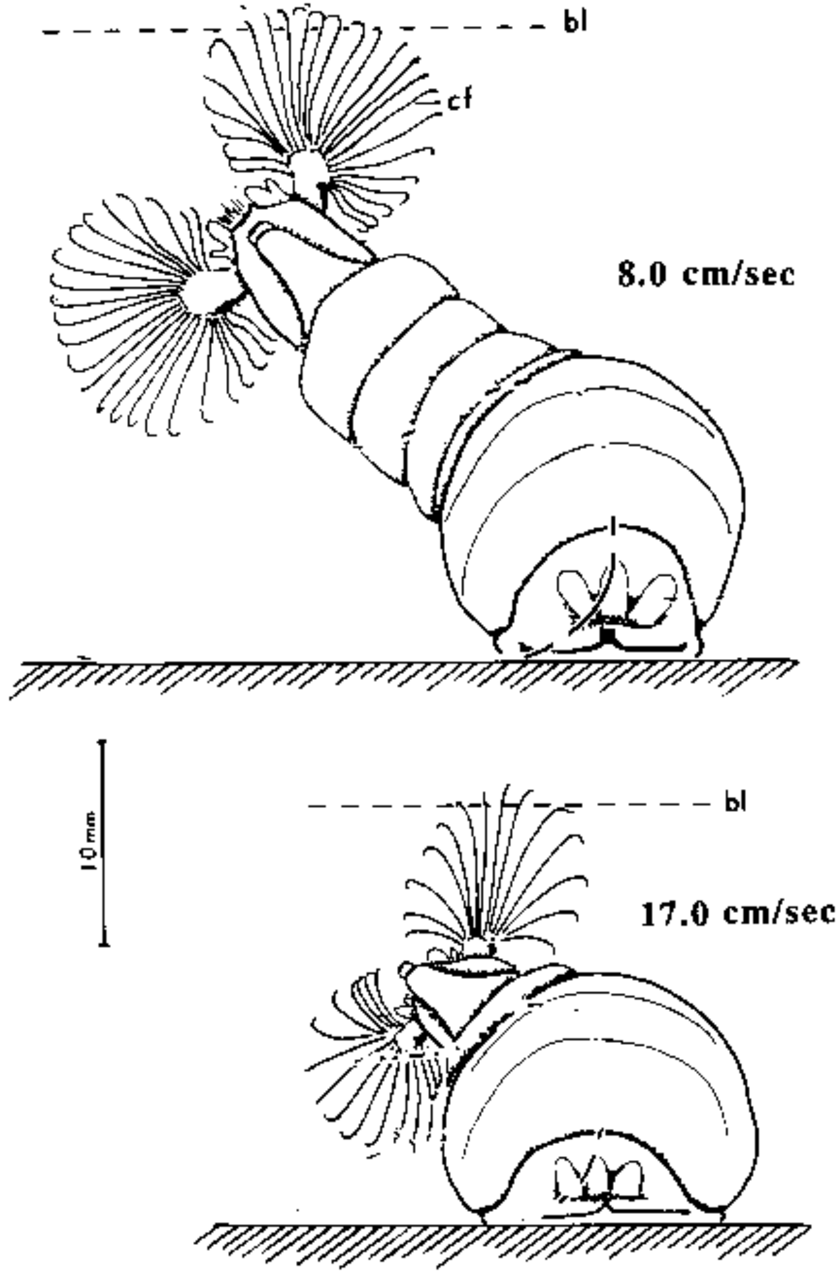


FIGURE 8.4. Drag coefficients of protuberances on flat plates, based on frontal area. The values have only relative significance since, in practice, they depend on the heights of the protuberances relative to the local boundary layer thickness, here assumed very thin.


bl
cf
8.0 cm/sec
l
bl
17.0 cm/sec
10mm

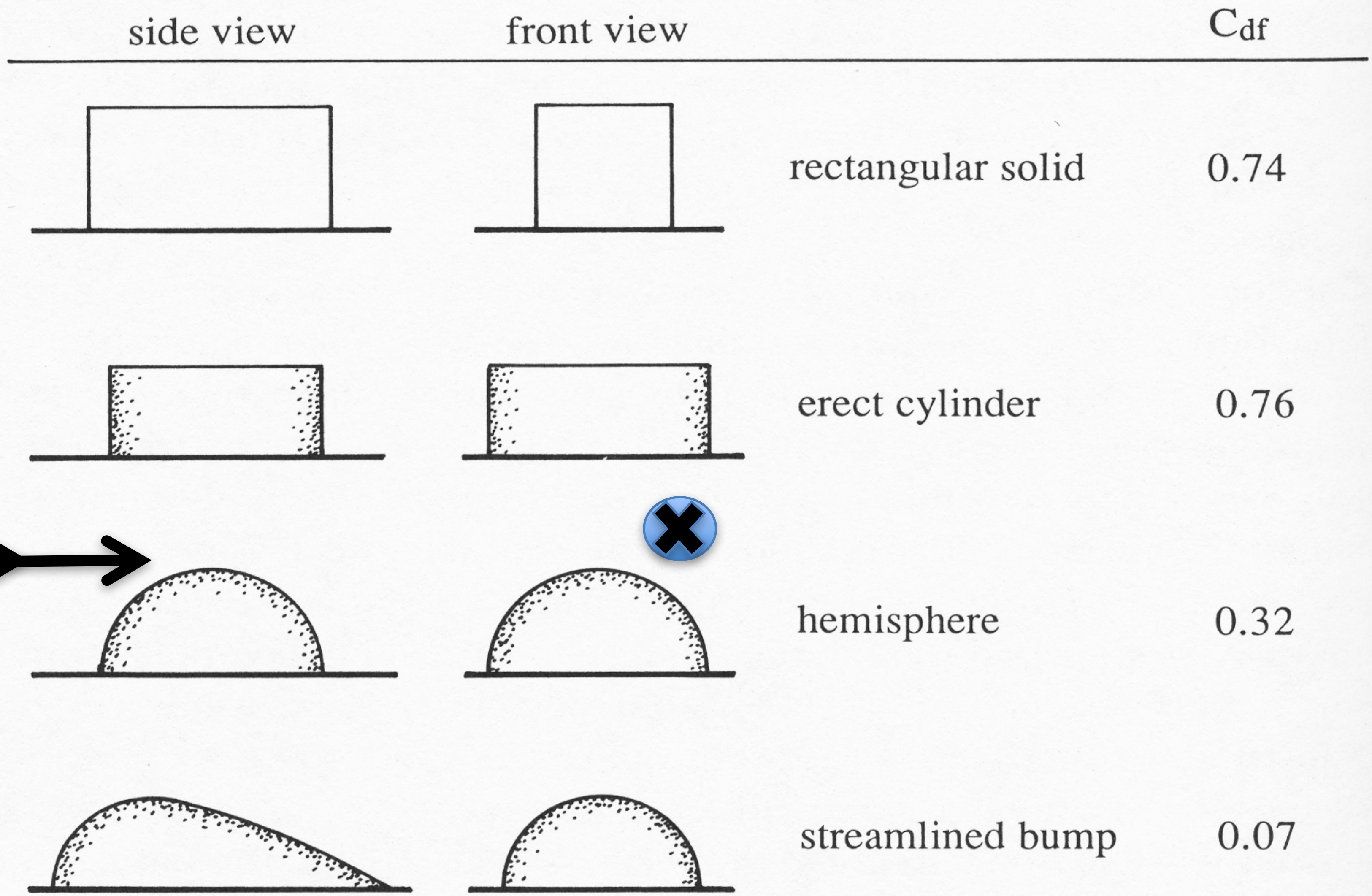
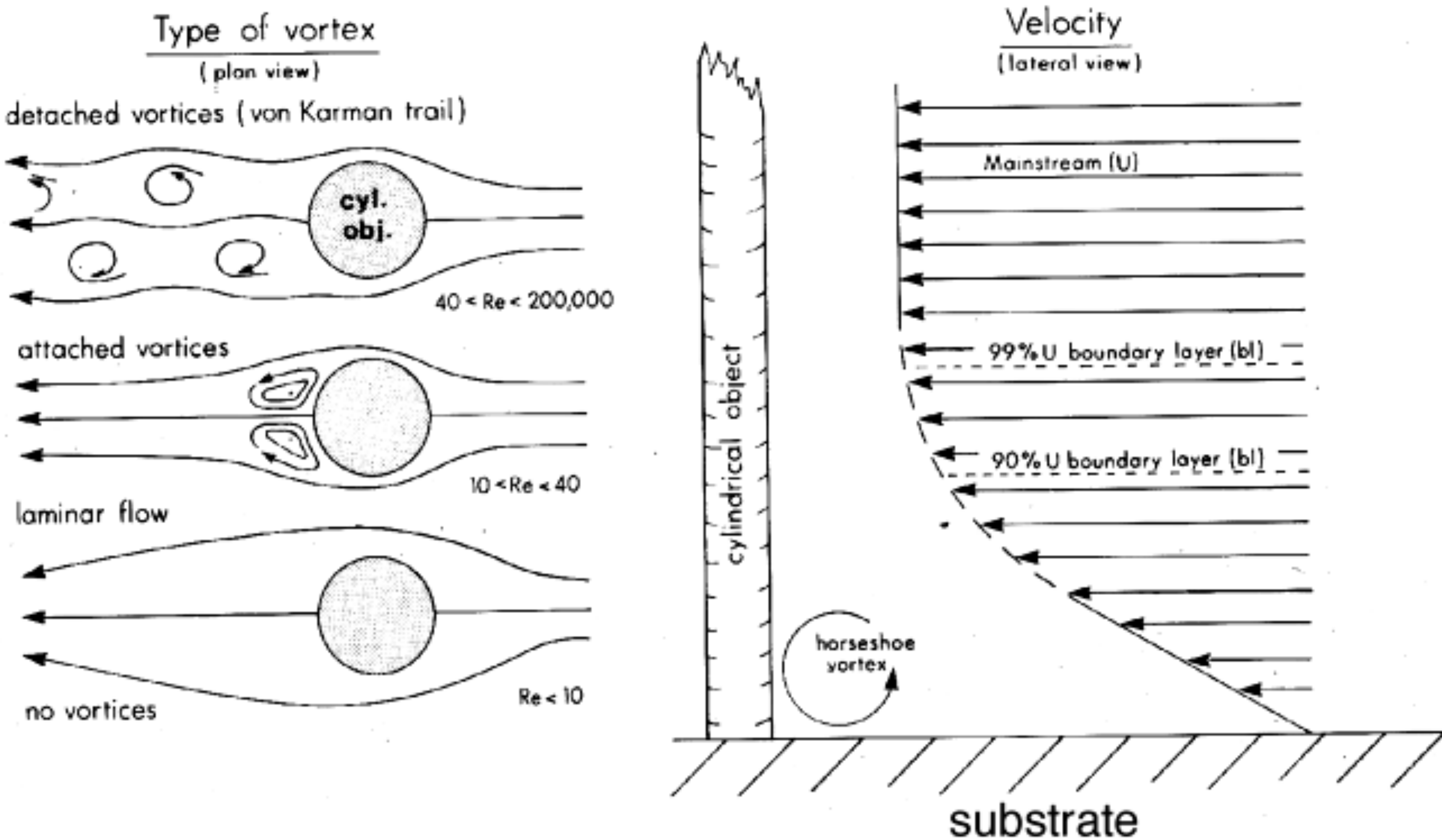
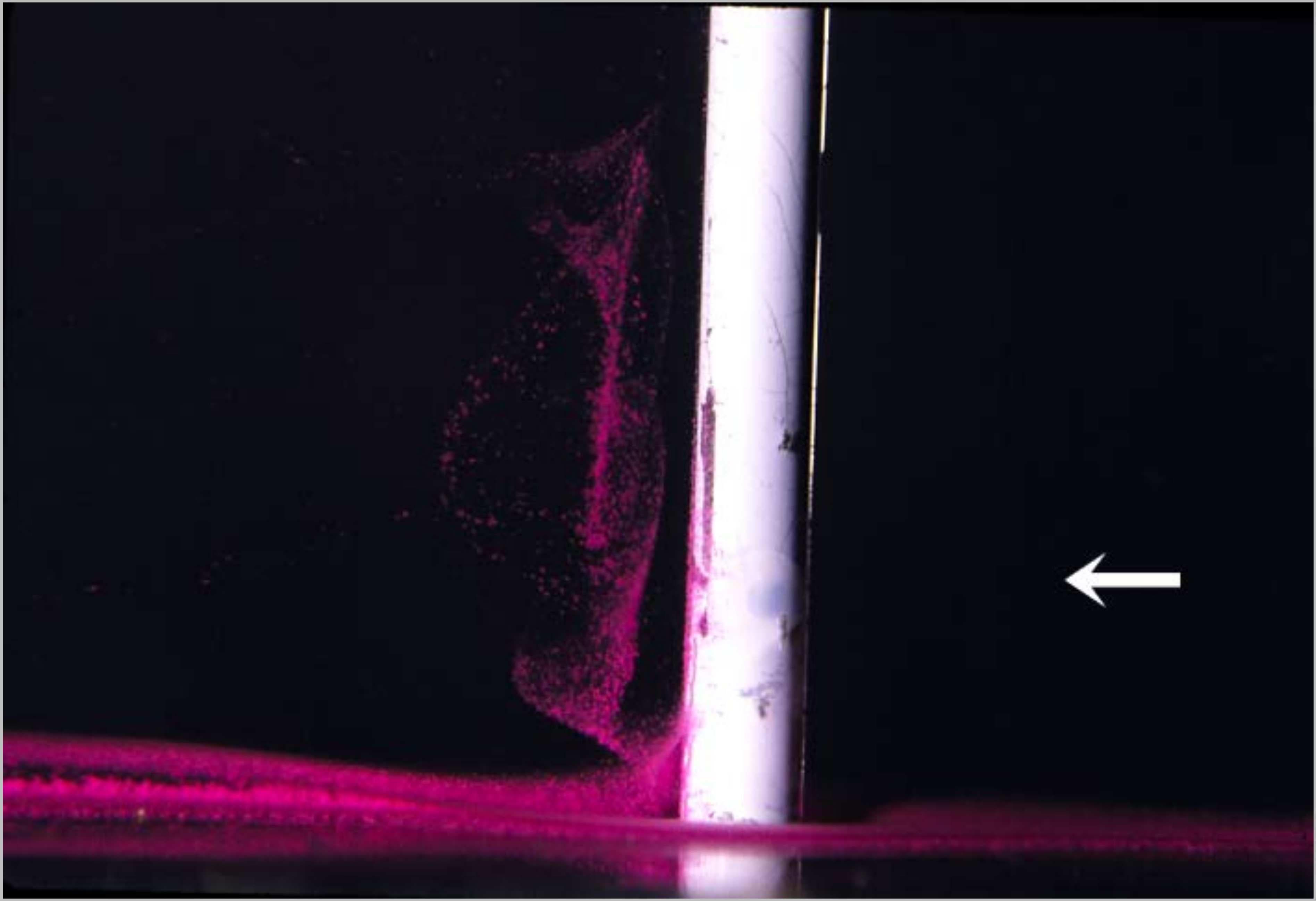


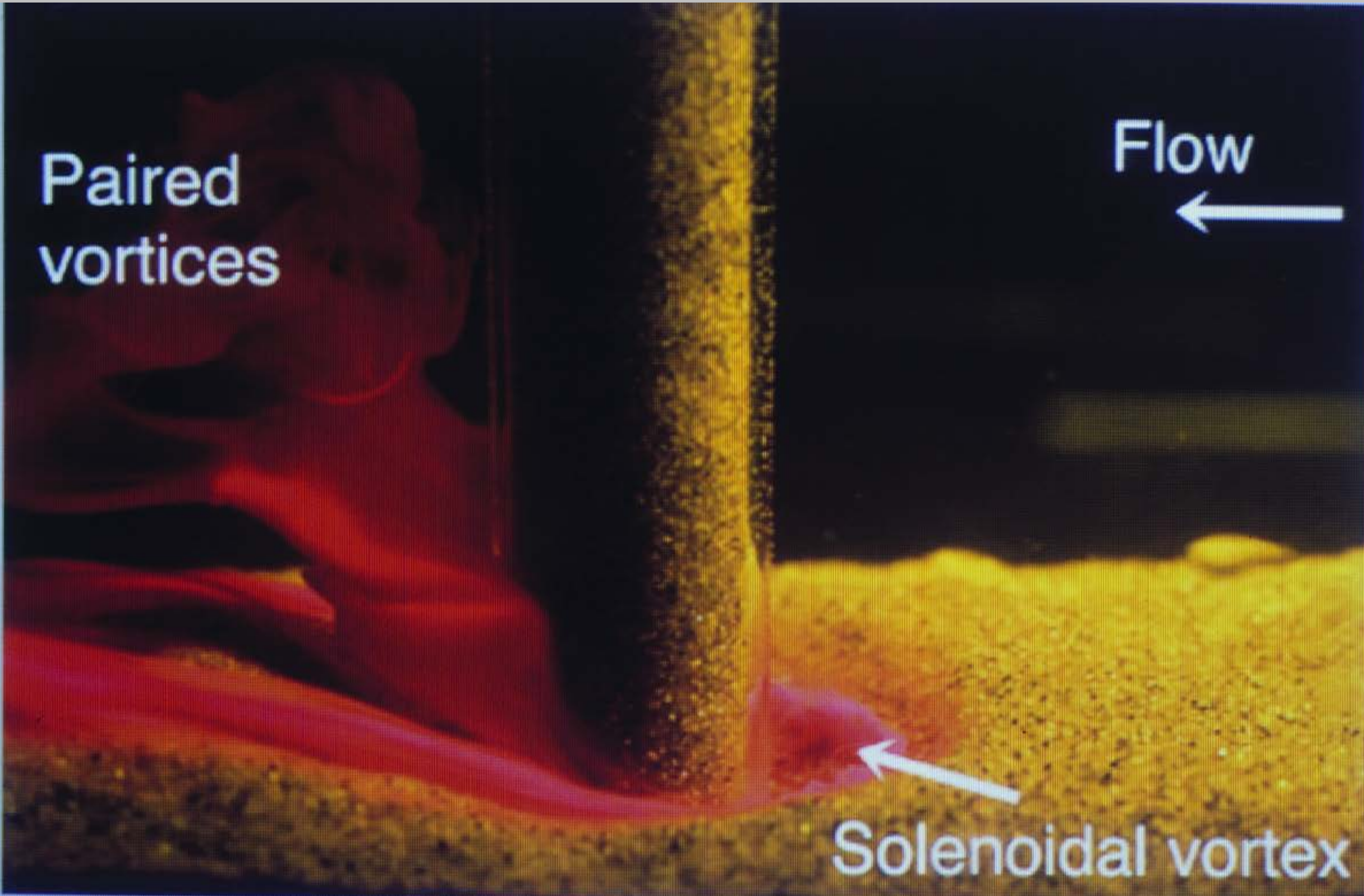
FIGURE 8.4. Drag coefficients of protuberances on flat plates, based on frontal area. The values have only relative significance since, in practice, they depend on the heights of the protuberances relative to the local boundary layer thickness, here assumed very thin.

Flow around an object (cylinder)

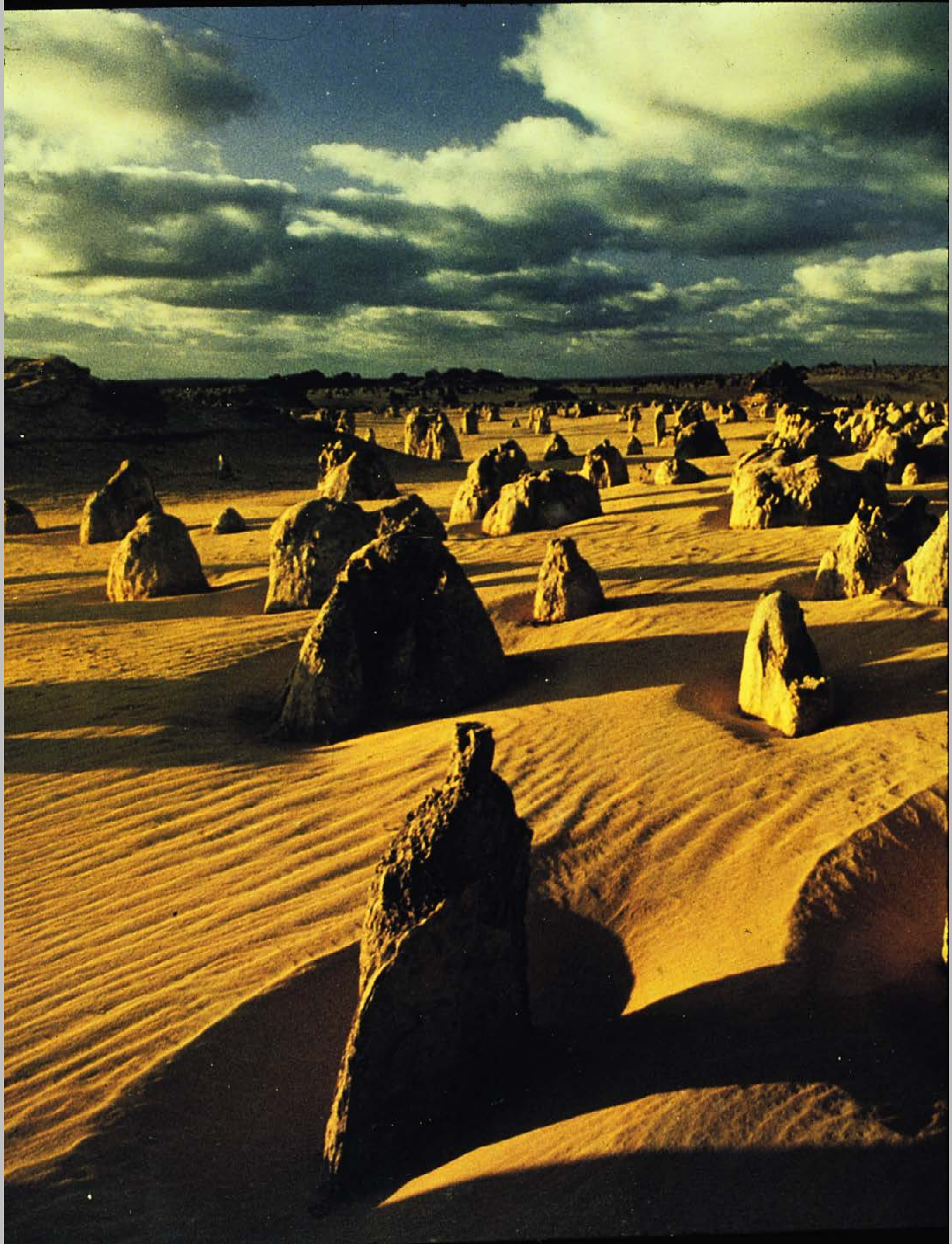


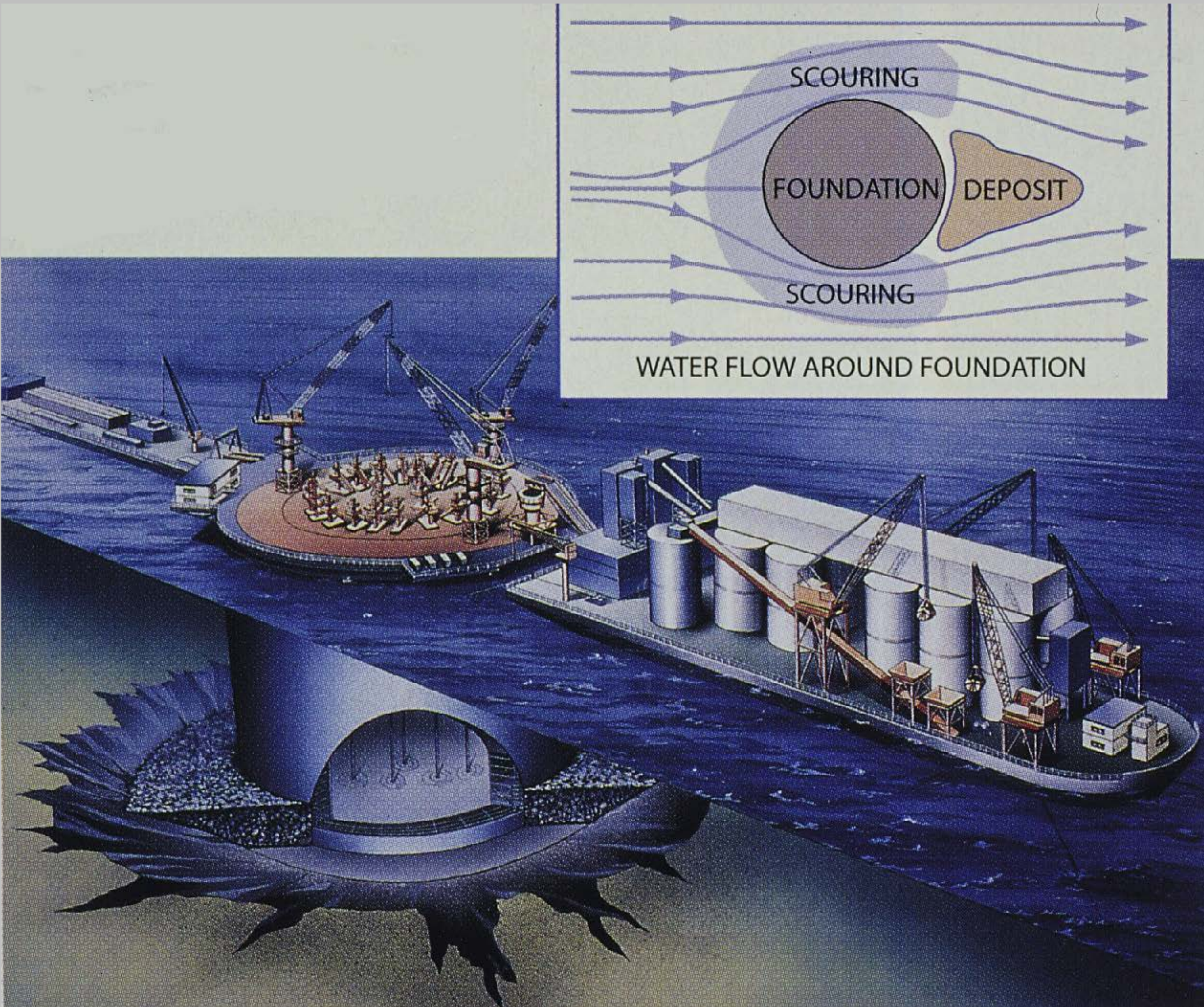


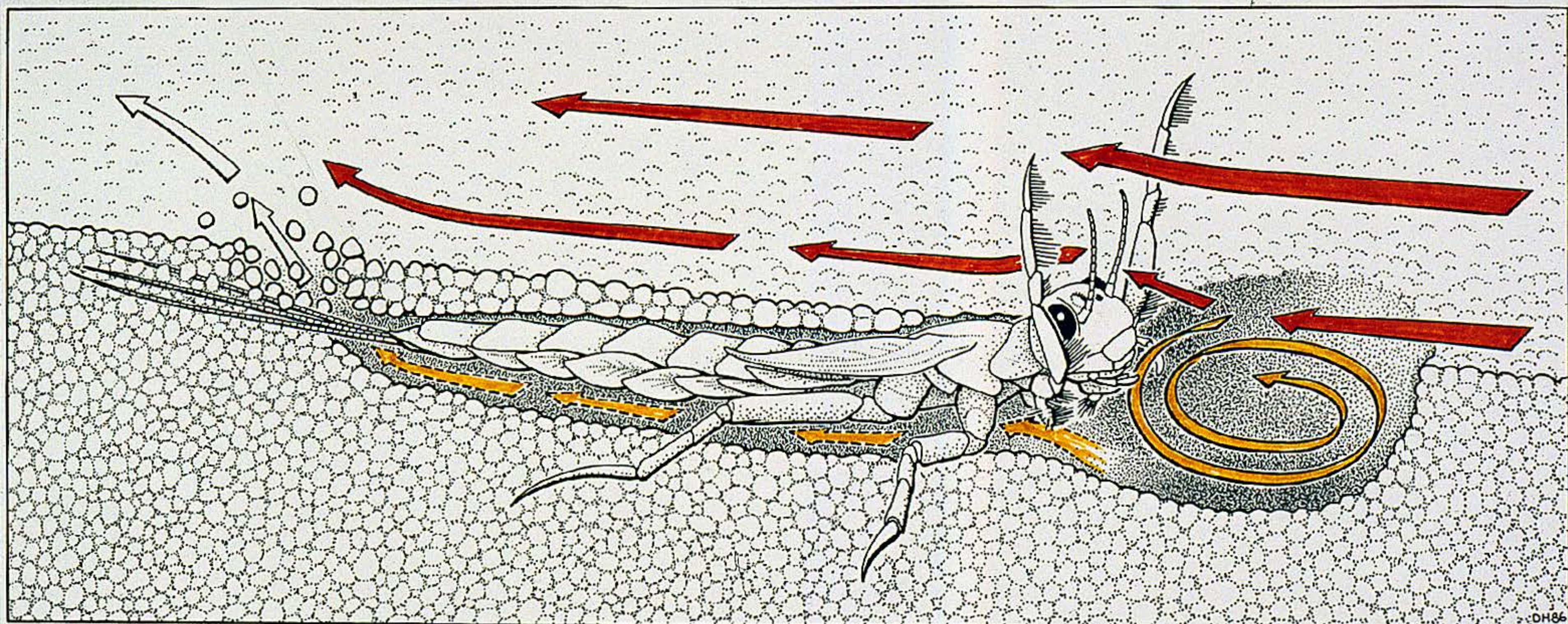

v
v
x
n

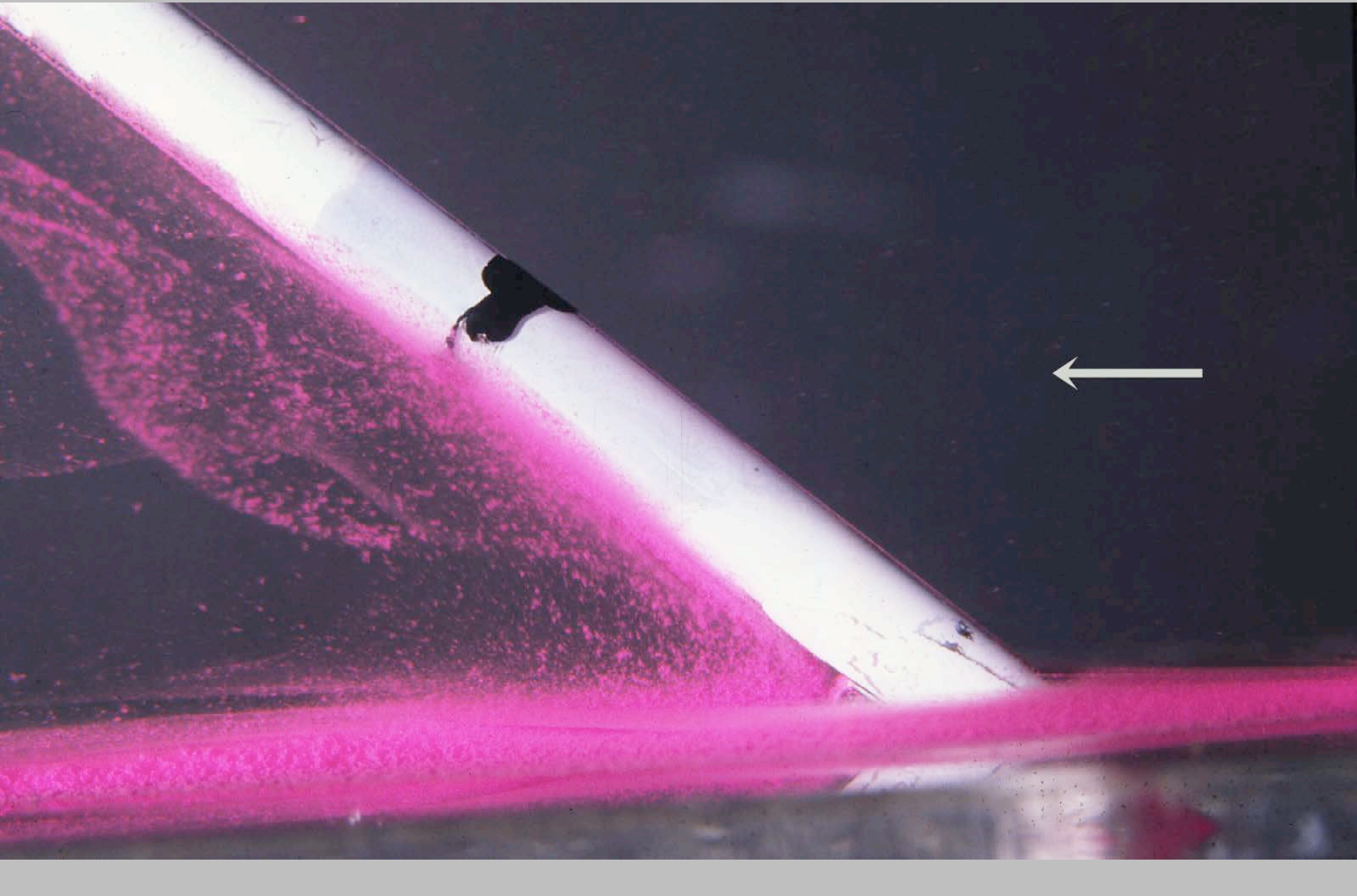


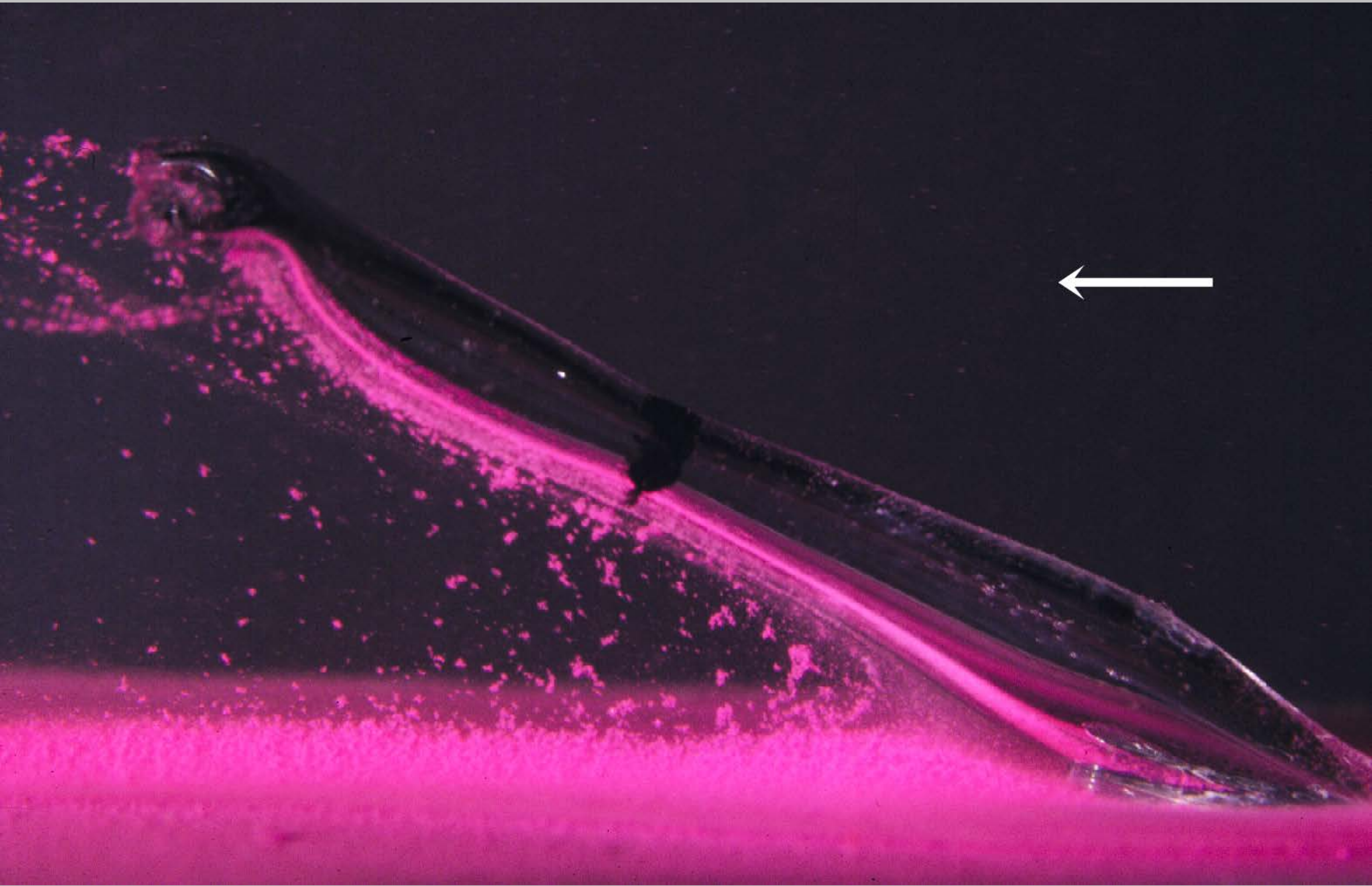
Paired vortices
Flow
Solenoidal vortex

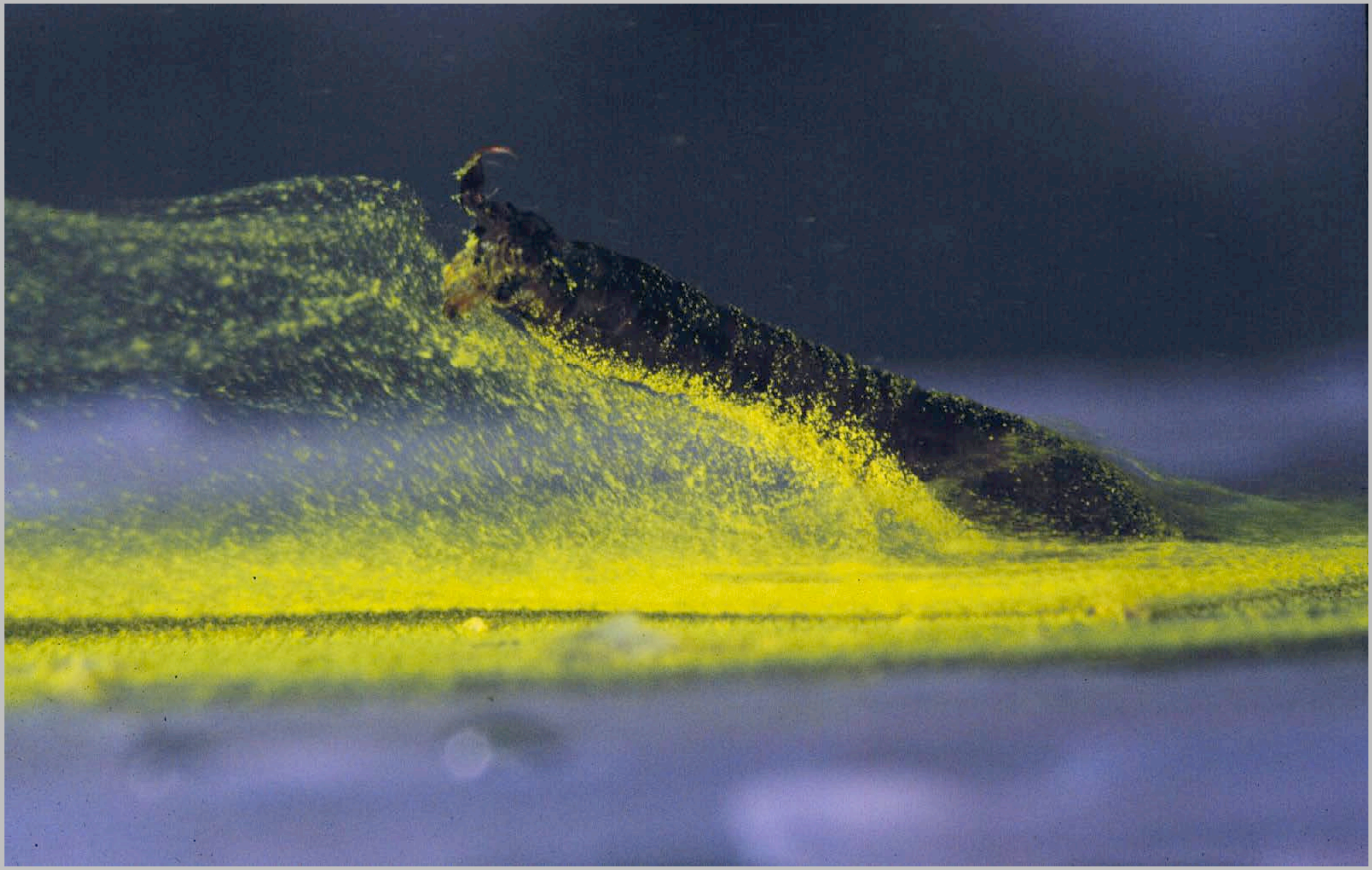



SCOURING
FOUNDATION
DEPOSIT
SCOURING
WATER FLOW AROUND FOUNDATION

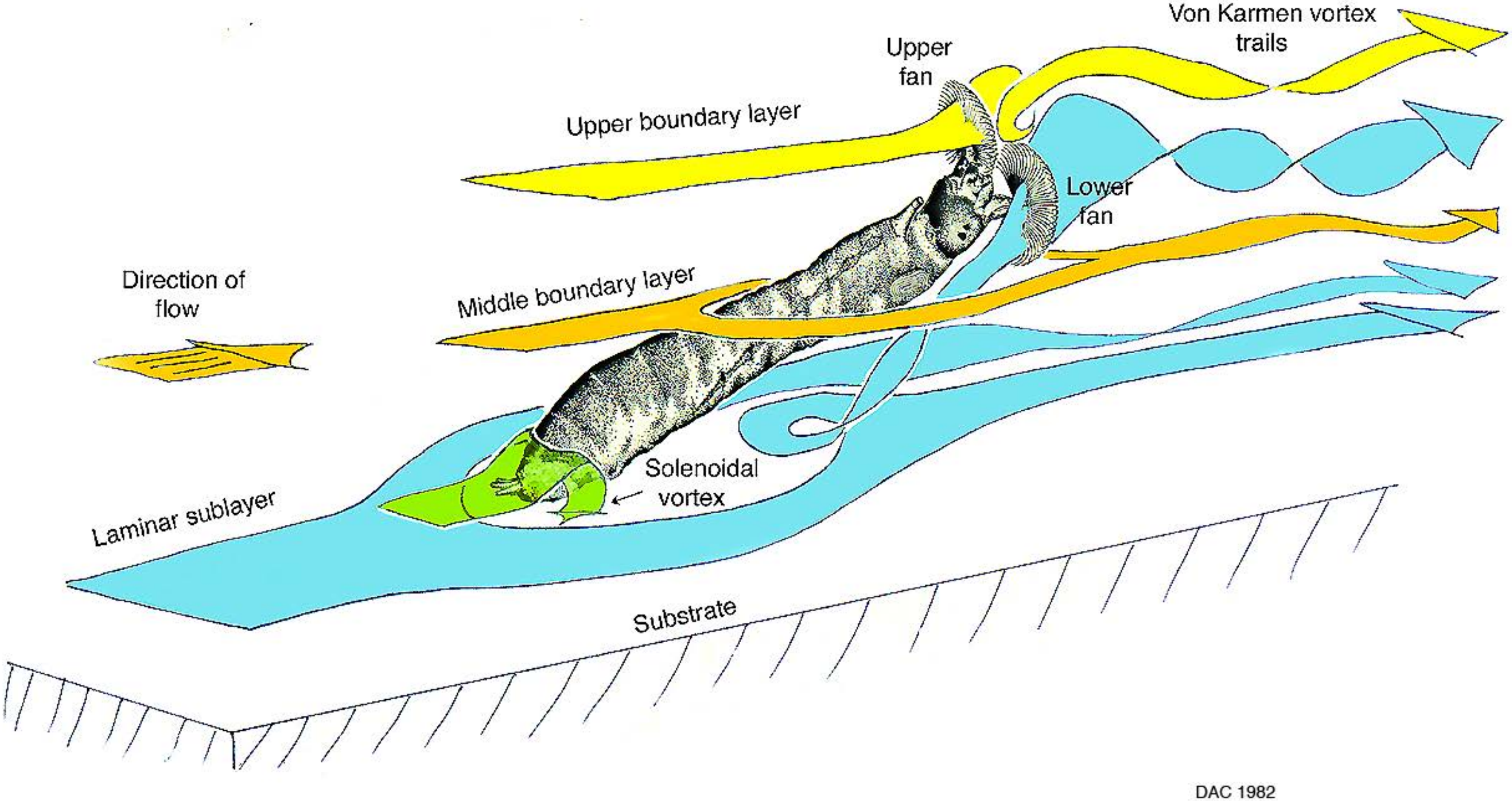

DH86

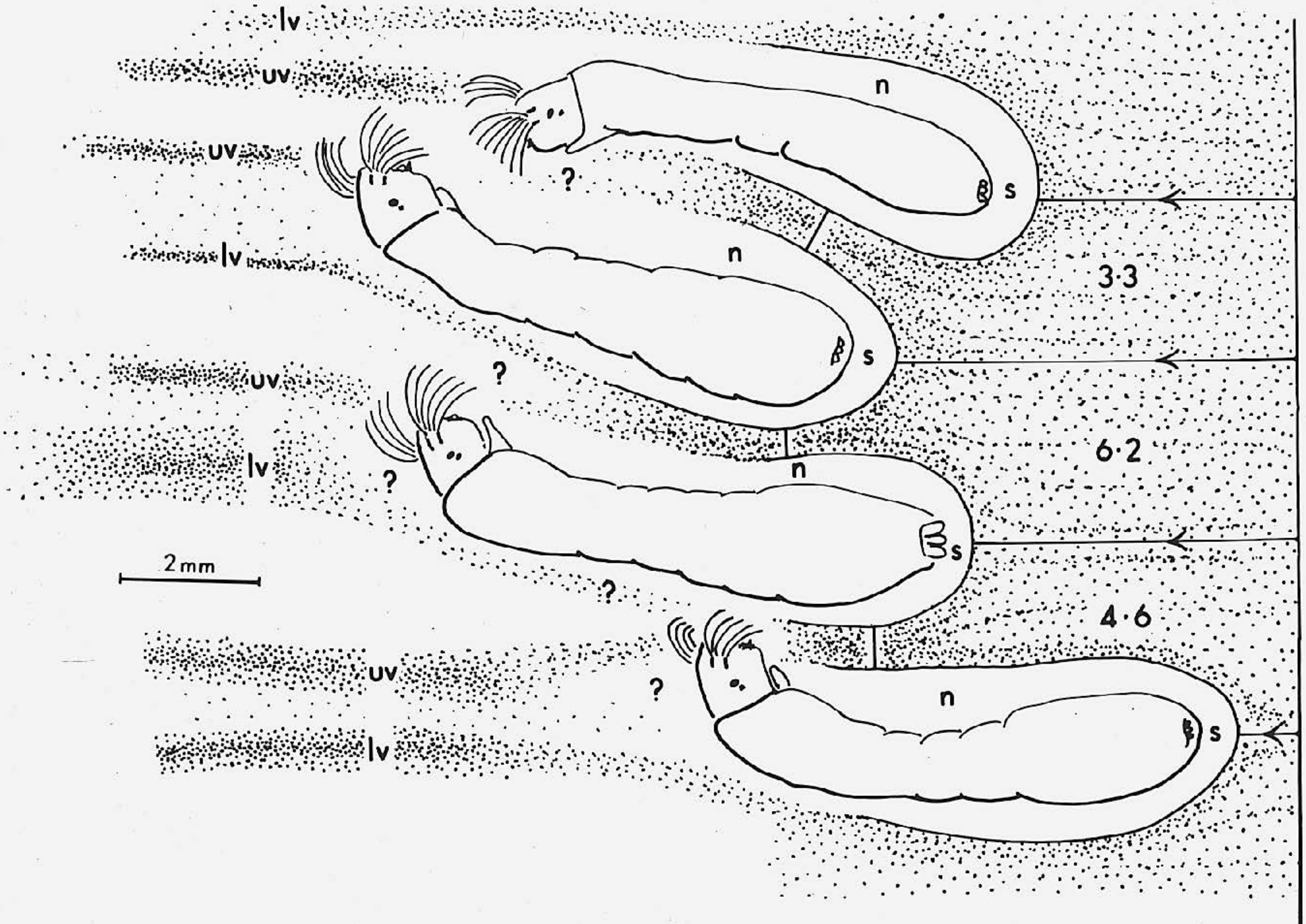




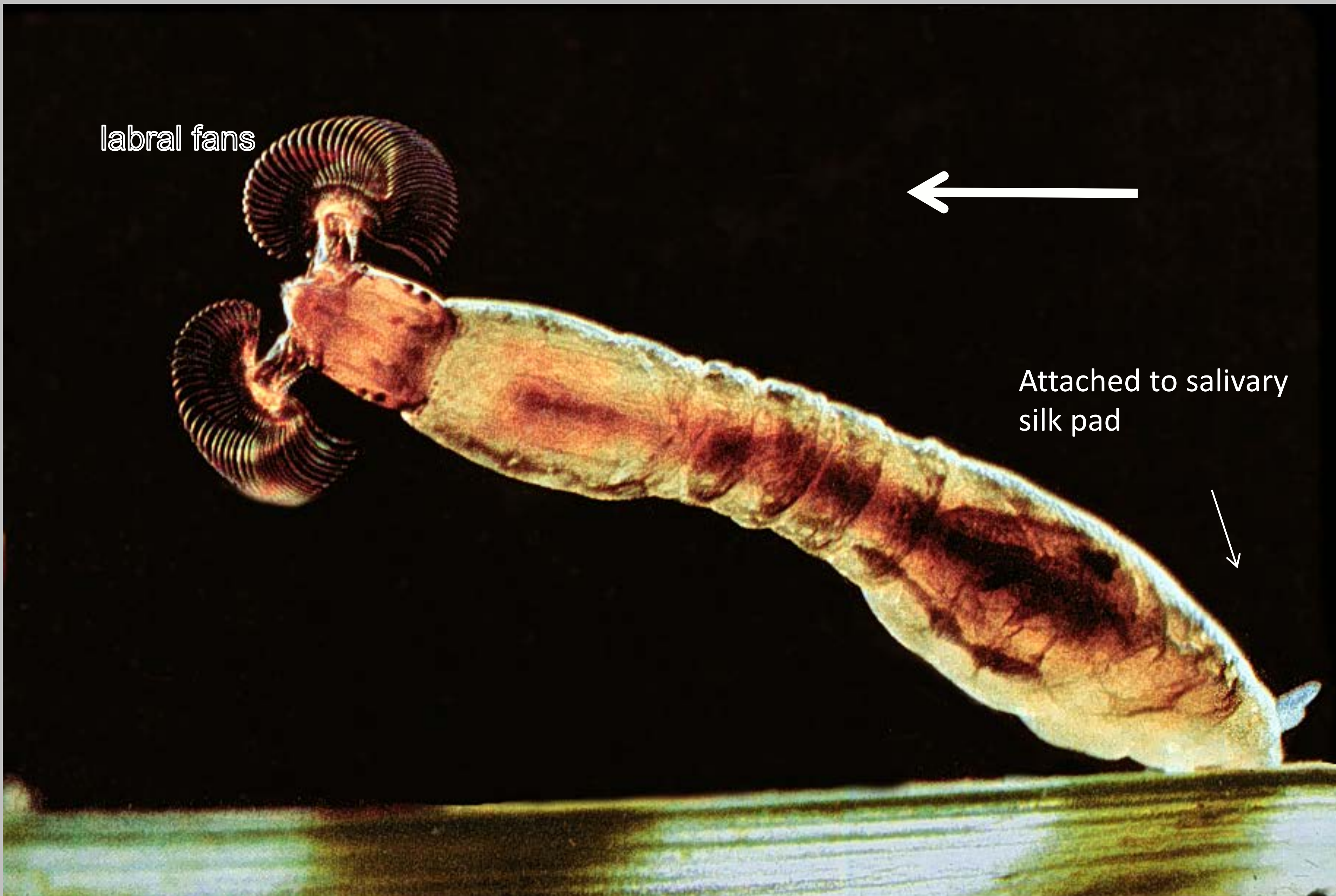


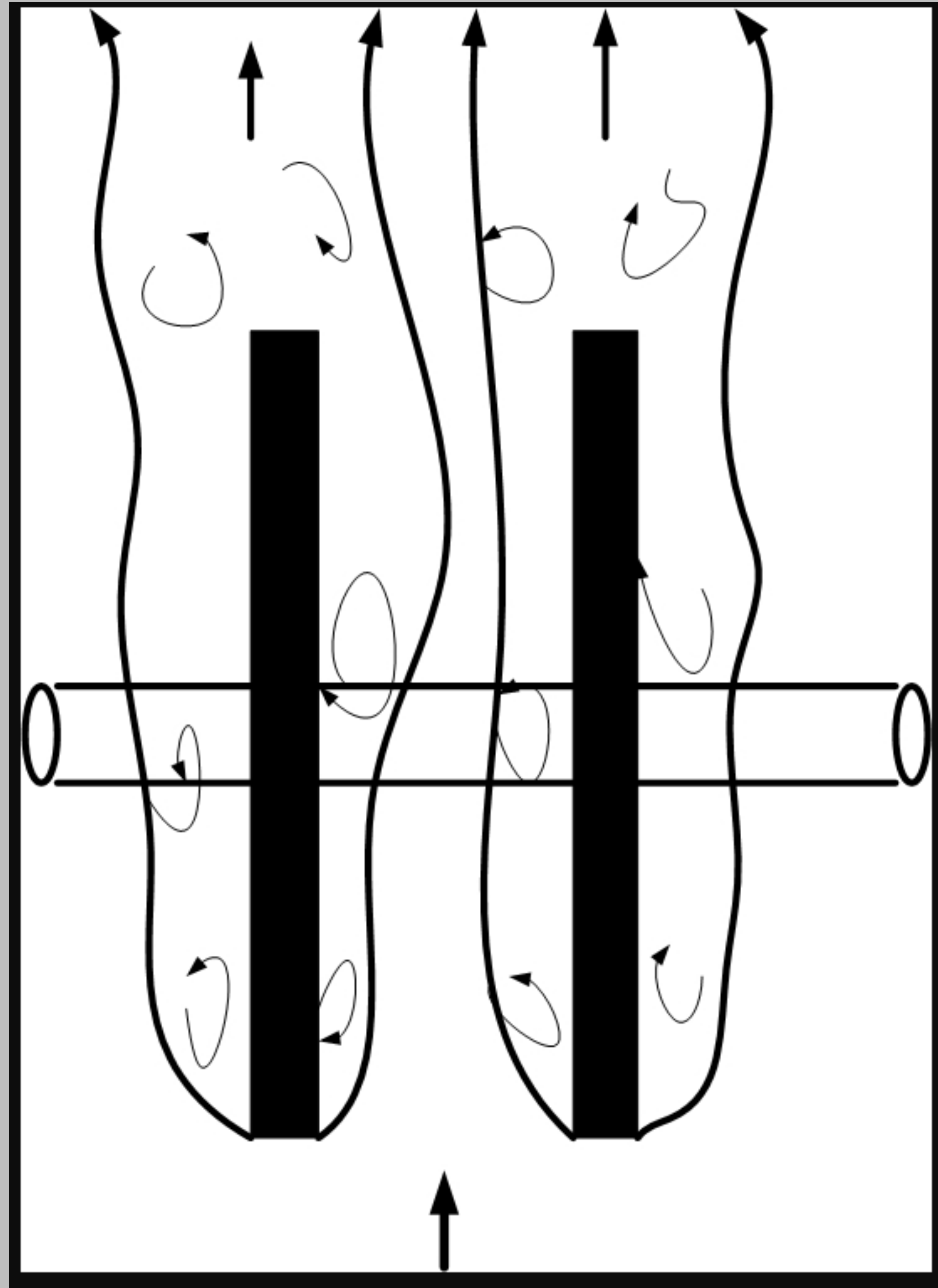
Generalized flow around a larva of *Simulium vittatum*





lv
uv
uv
lv
uv
lv
uv
lv
n
n
n
n
s
s
s
s
?
?
?
?
?
3·3
6·2
4·6
2mm


labral fans
Attached to salivary silk pad



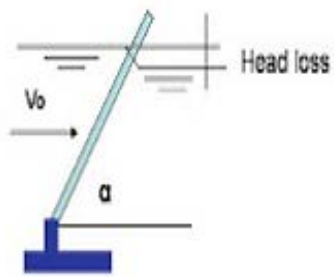
Trash rack (or screen) losses

By Ahmad Suhendra

A screen is always required at the entrance of a pressure pipe . The function of screen (trash rack) is :

keep debris away from the entrance to the outlet works where the debris will not clog the critical portions of the structure;

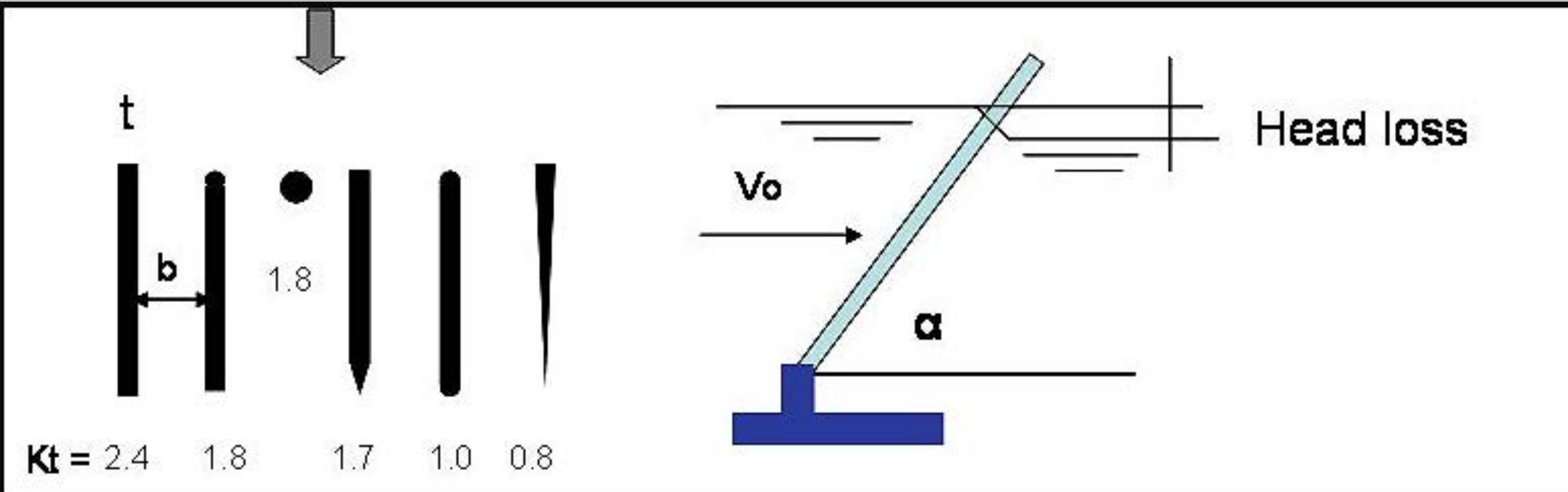
capture debris in such a way that relatively easy removal is possible;



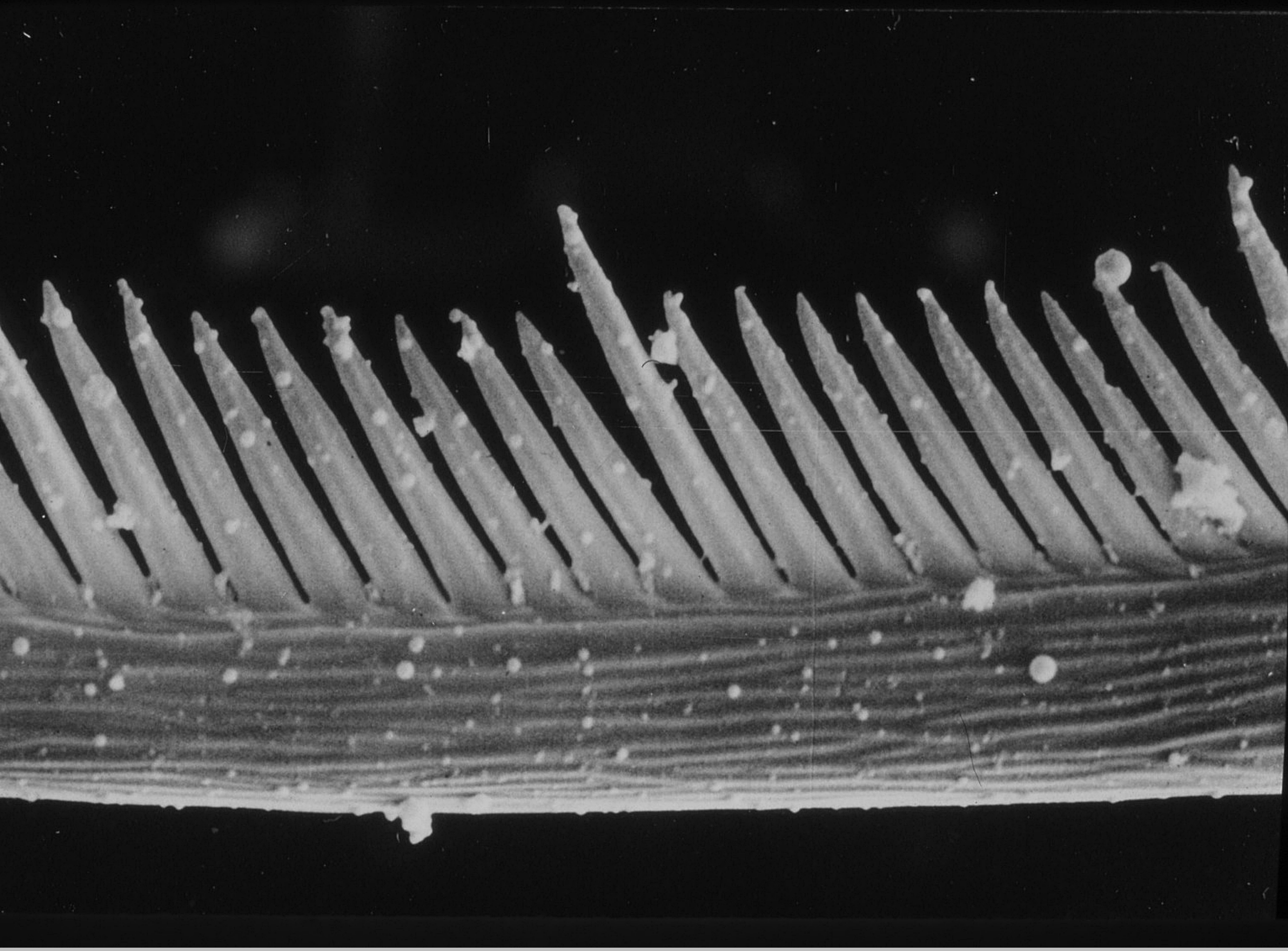
The flow of water through the rack also gives rise to a head loss. Though usually small, it can be calculated by a formula due to Kirchmer .

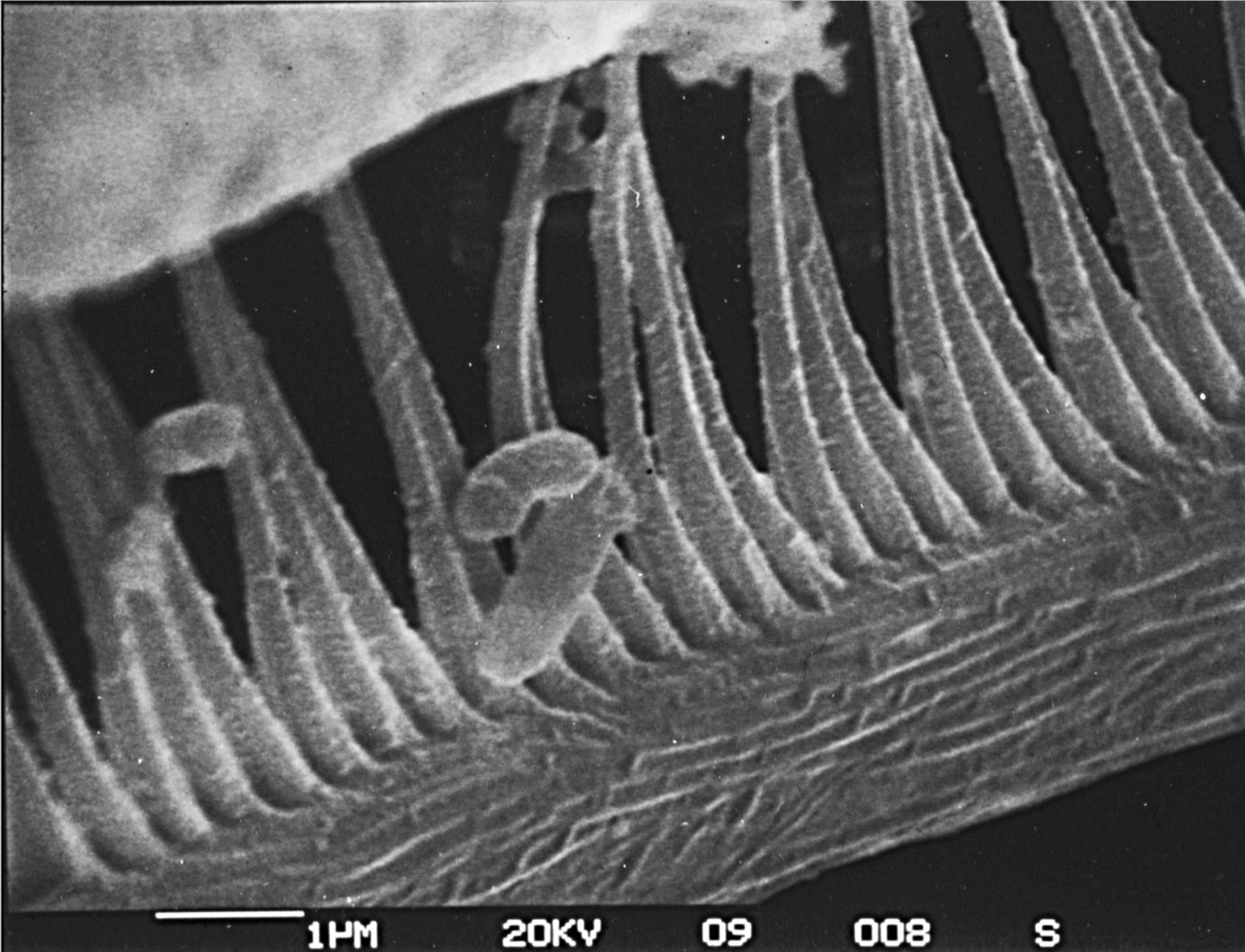
$$\mathbf{ht = [Kt \cdot (t / b)^{(4 / 3)} \cdot (Vo^2 \cdot \sin \alpha)] / (2 \cdot g)}$$

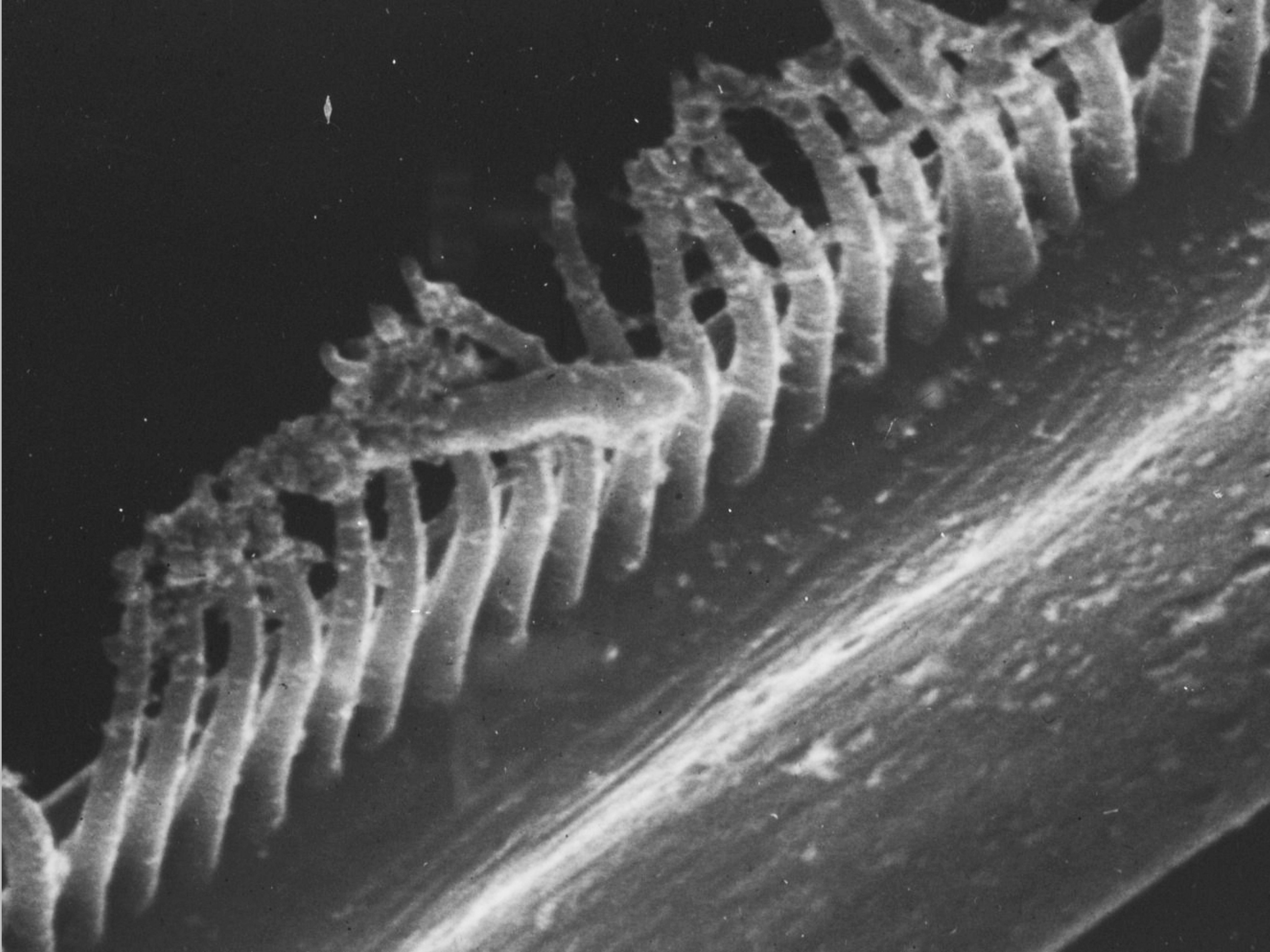
ht = Screen head loss (m)
Kt = Resistance coefficient
t = Bar thickness (mm)
b = Width between bars (mm)
Vo= Approach velocity (m/s)
g = Gravitational constant (9.8 m/s^2)
α = Angle of inclination from horizontal

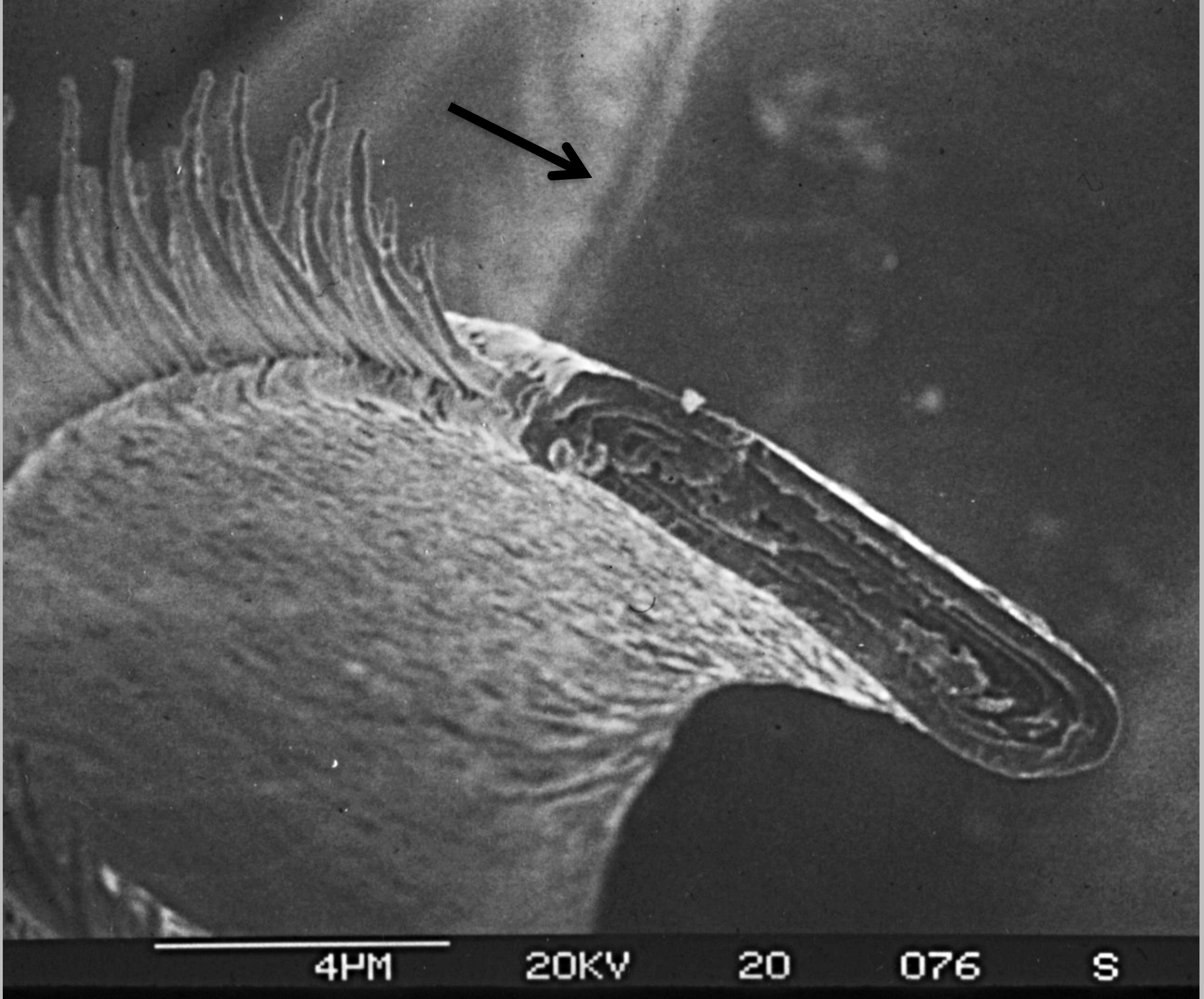


t
b
1.8
Kt = 2.4 1.8 1.7 1.0 0.8
Vo
α
Head loss

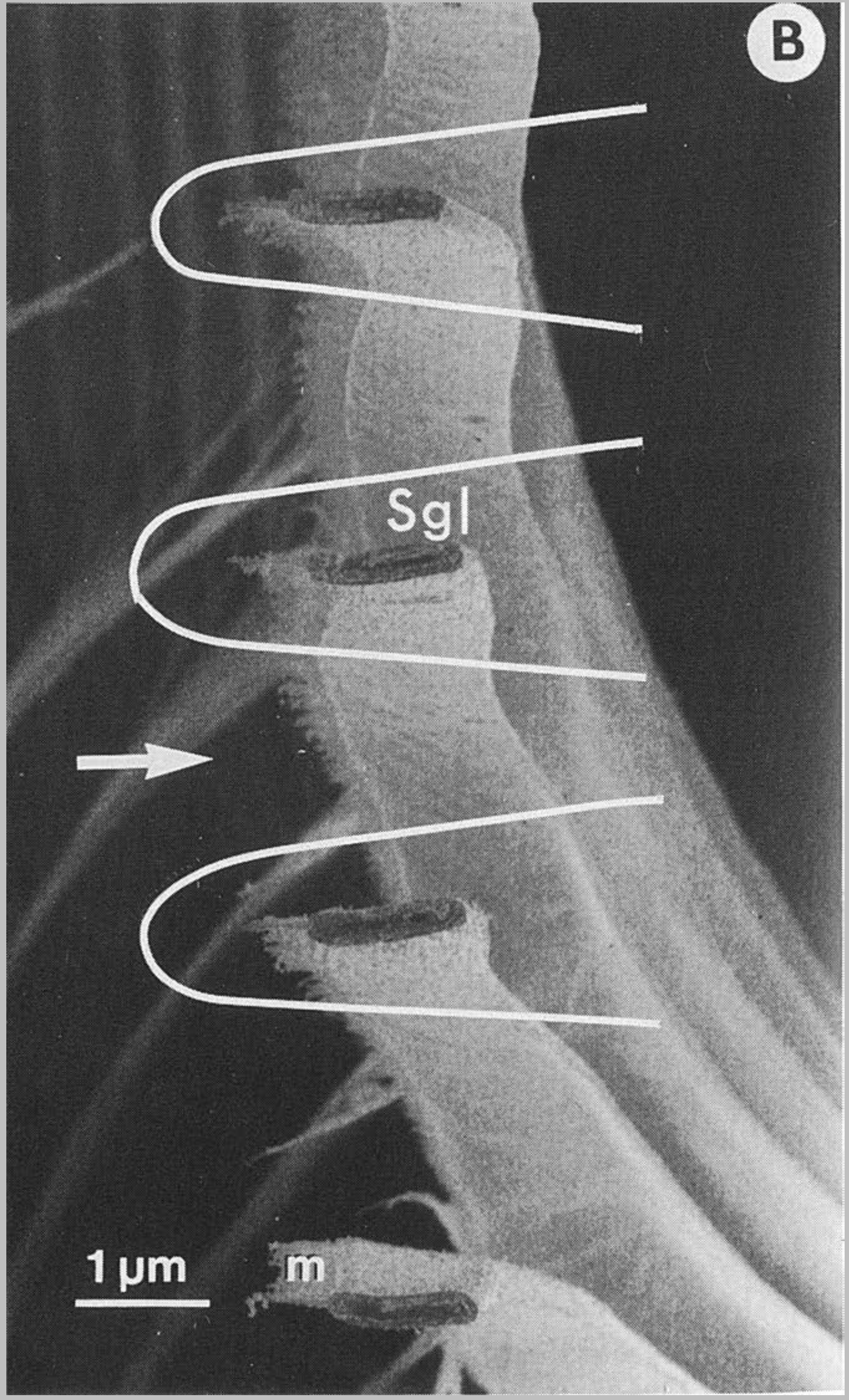



1ΜM
20KV
09
008
S





4PM
20KV
20
076
S


B
Sgl
1 µm
m

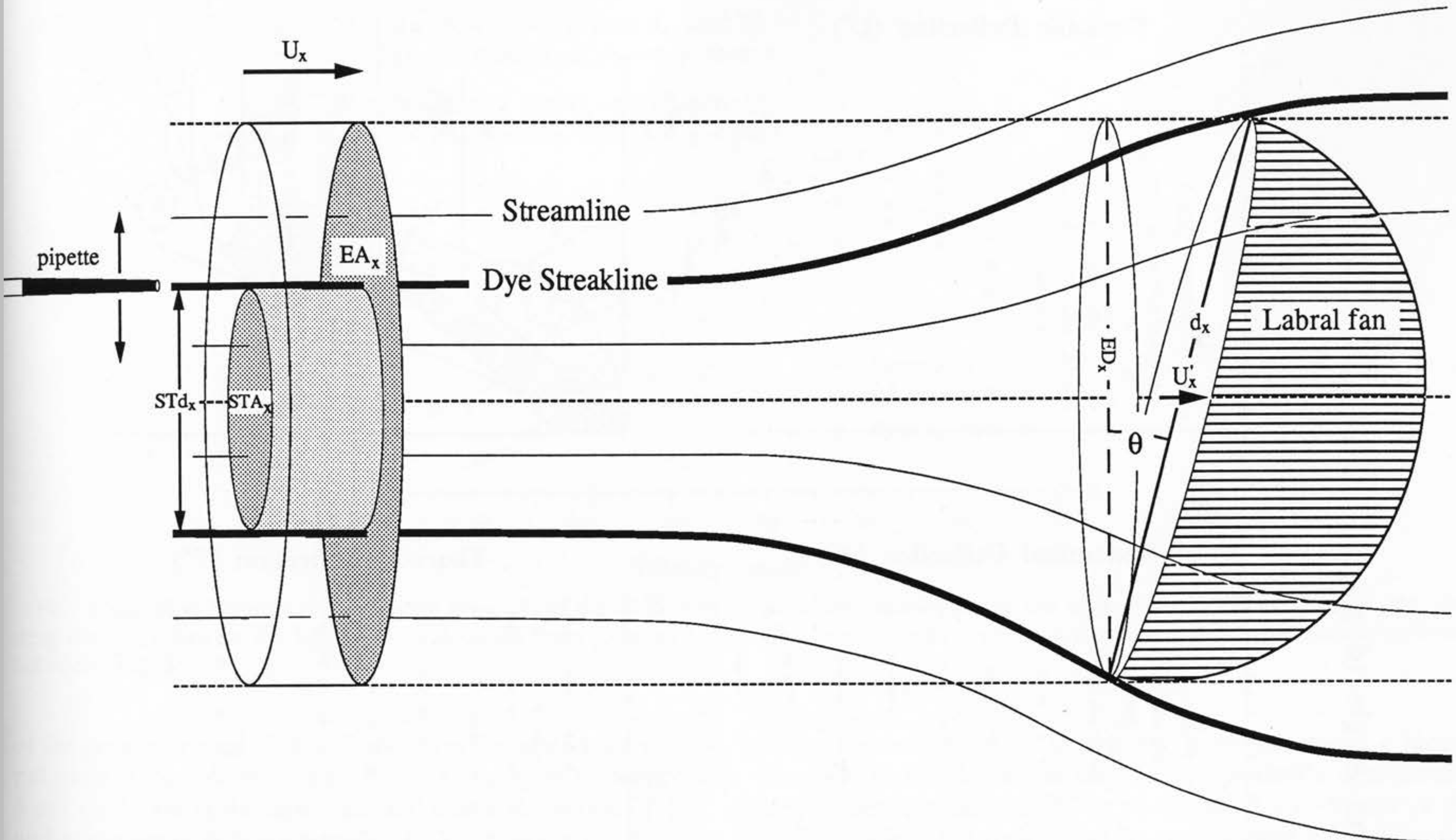
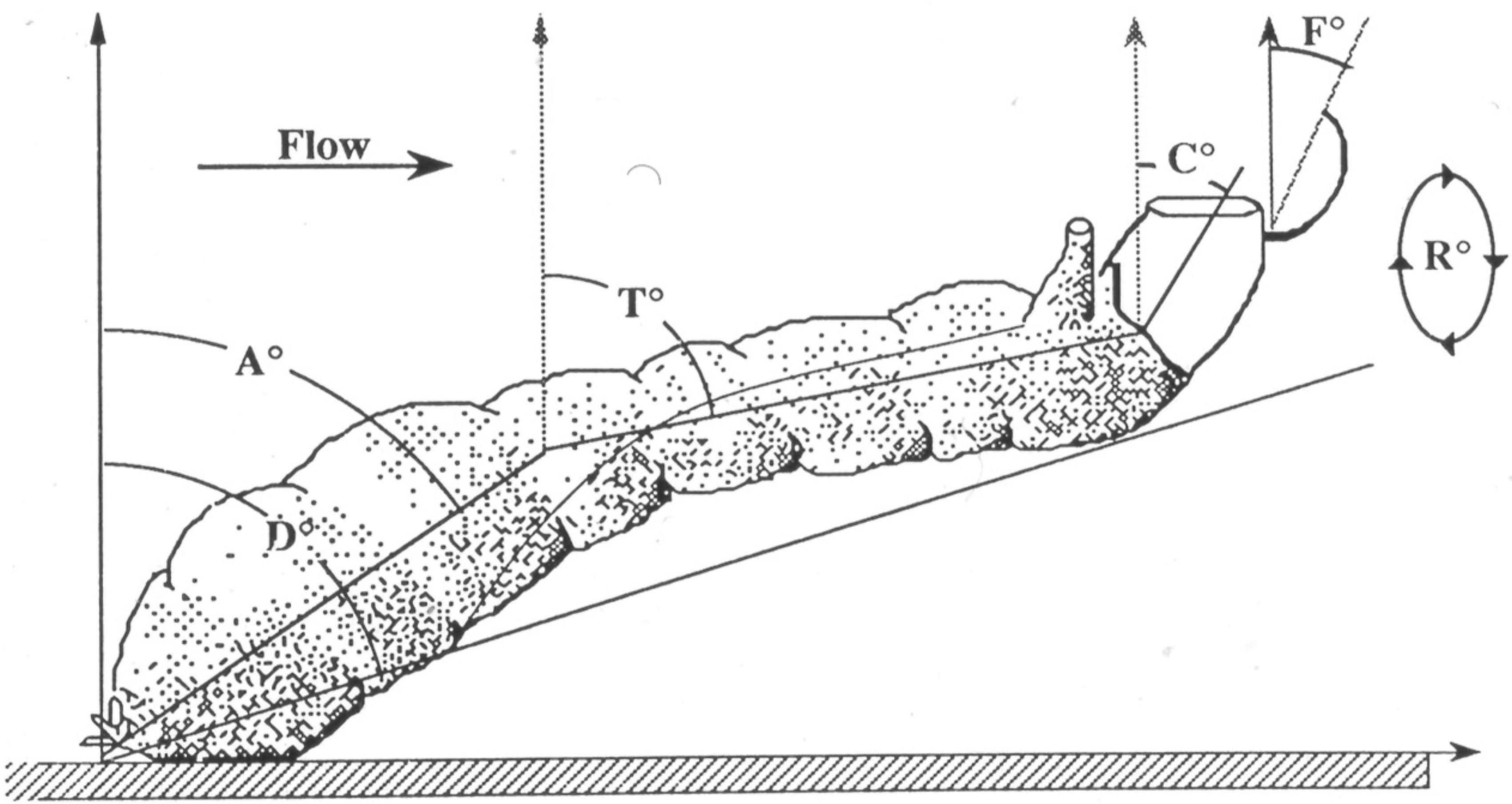
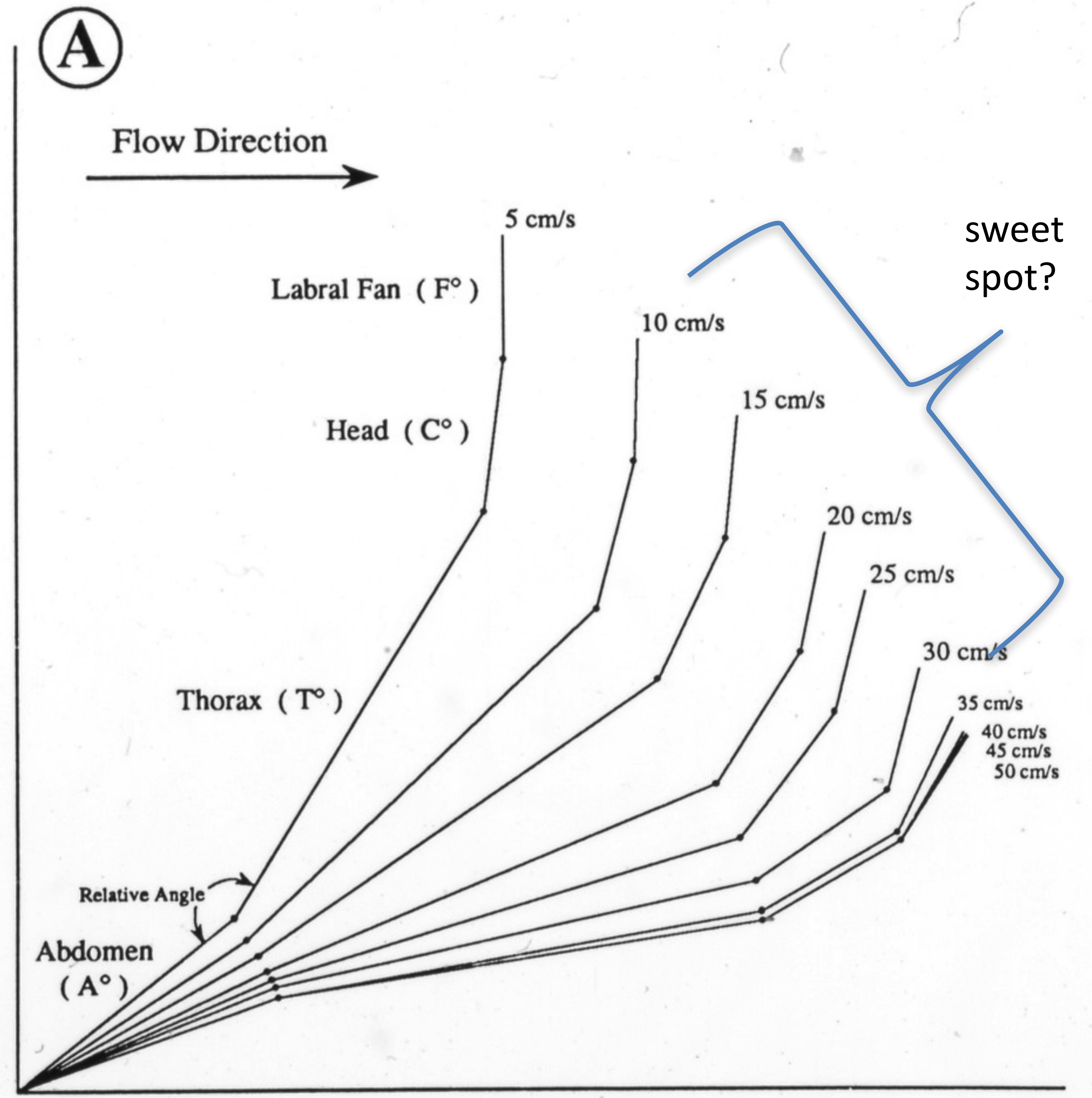
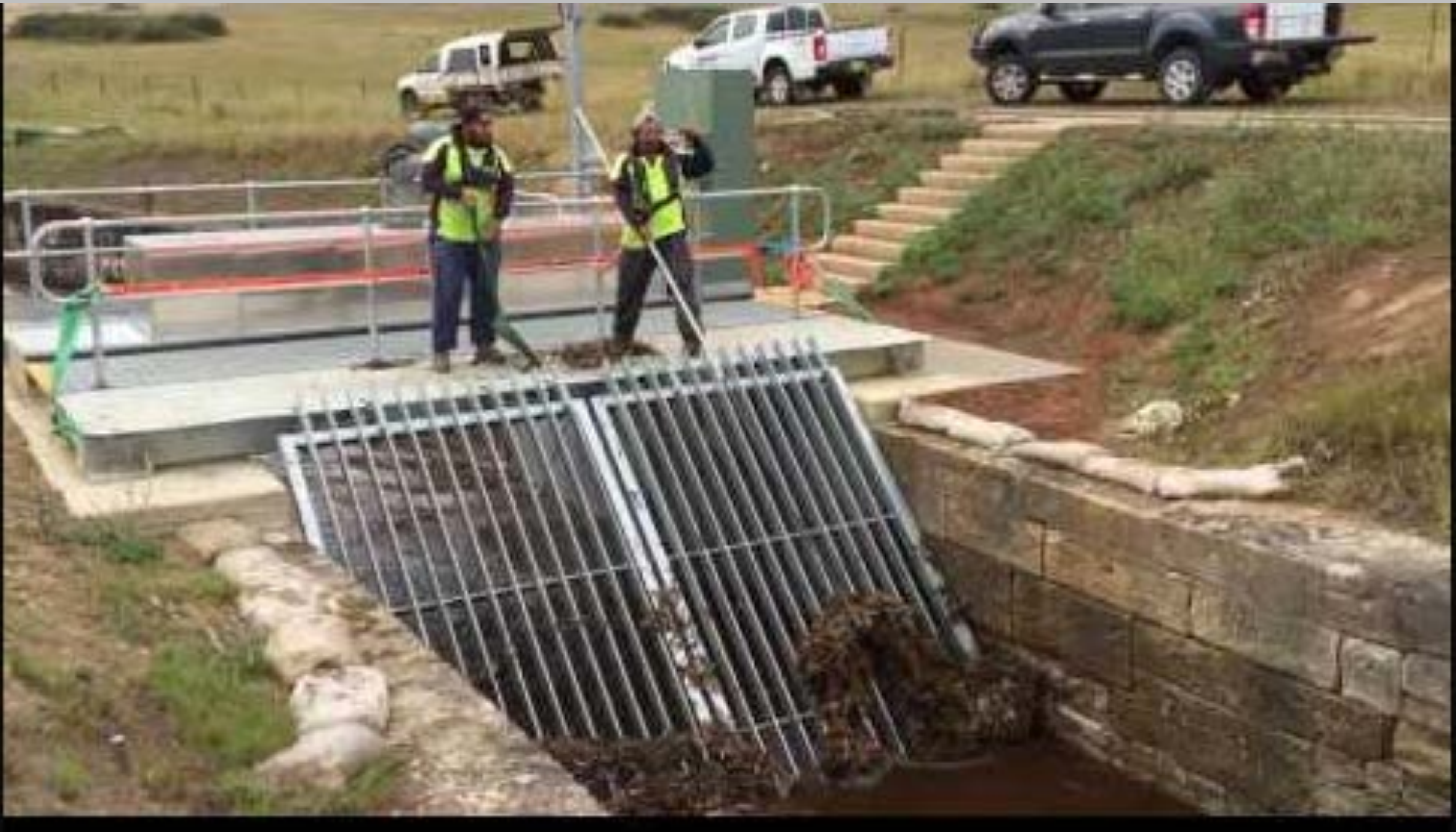


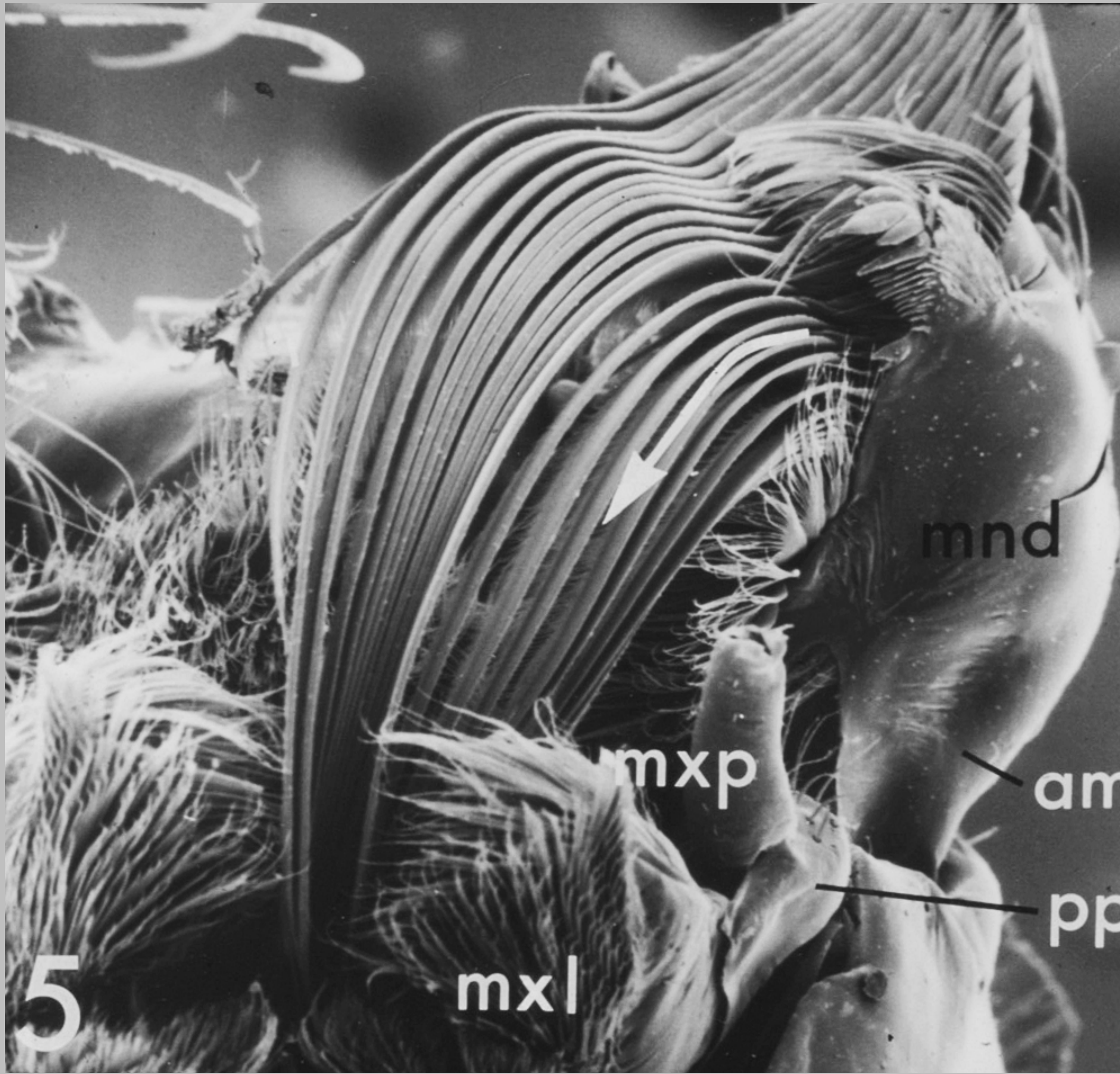
FIG. 4. Schematic representation of fluid flow through a simuliid labral fan: d_x, labral fan diameter; EA_x, effective fan aperture; ED_x, effective fan aperture diameter; STA_x, streamtube cross-sectional area; STd_x, streamtube diameter; U_x, free-stream water velocity; U'_x, water velocity through the labral fan; θ, labral fan deflection angle.

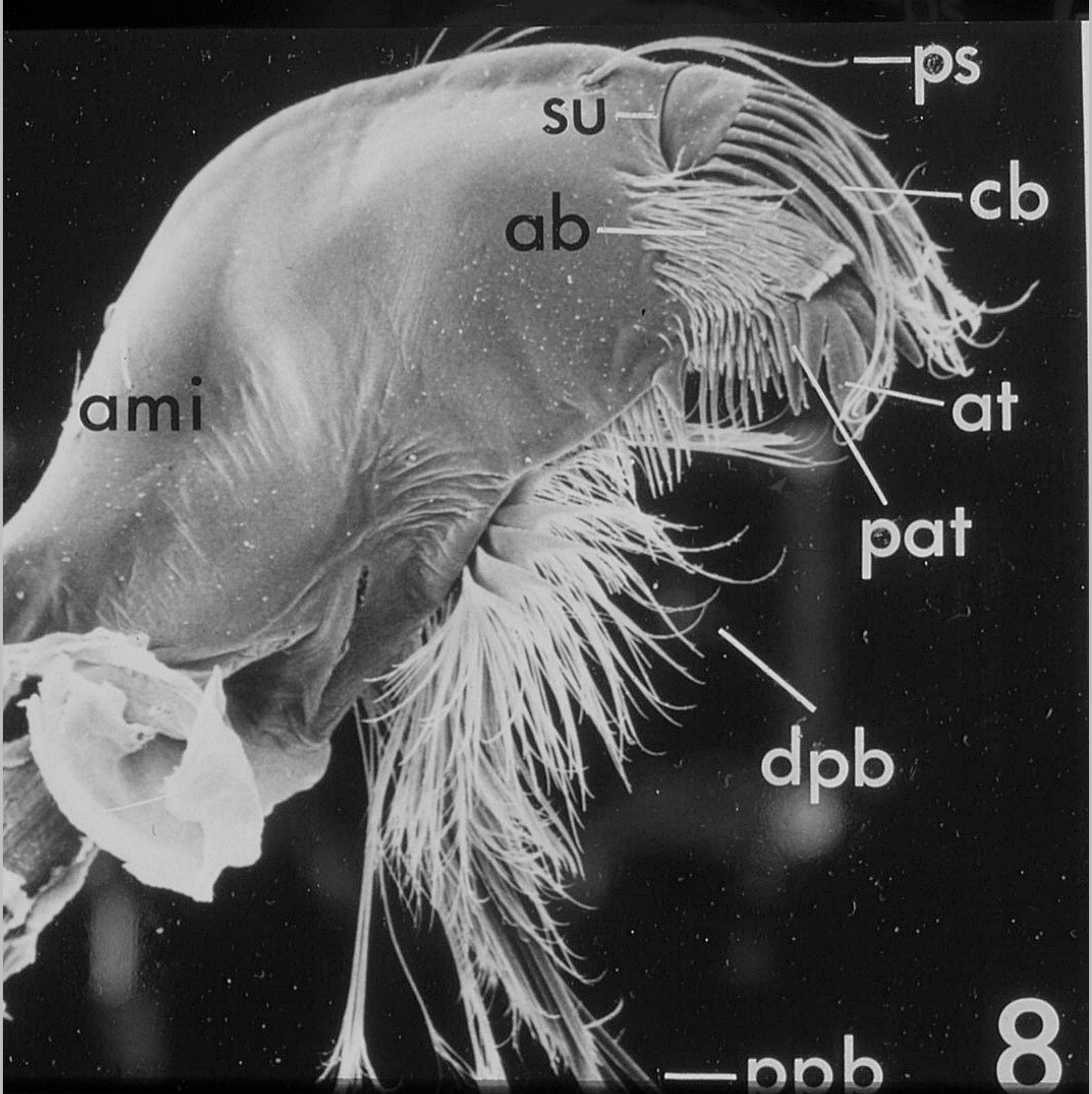


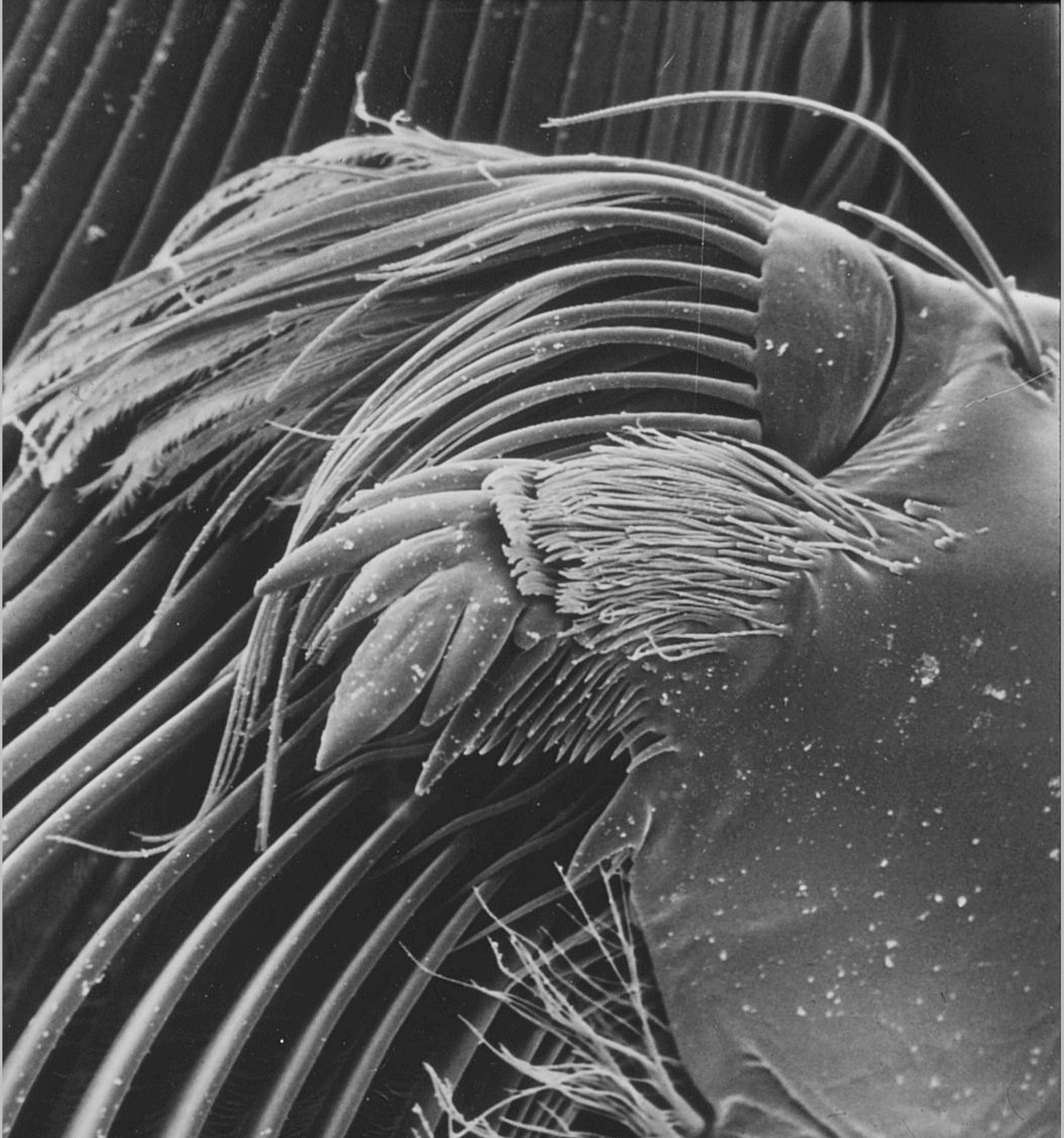
Flow
A°
D°
T°
C°
F°
R°

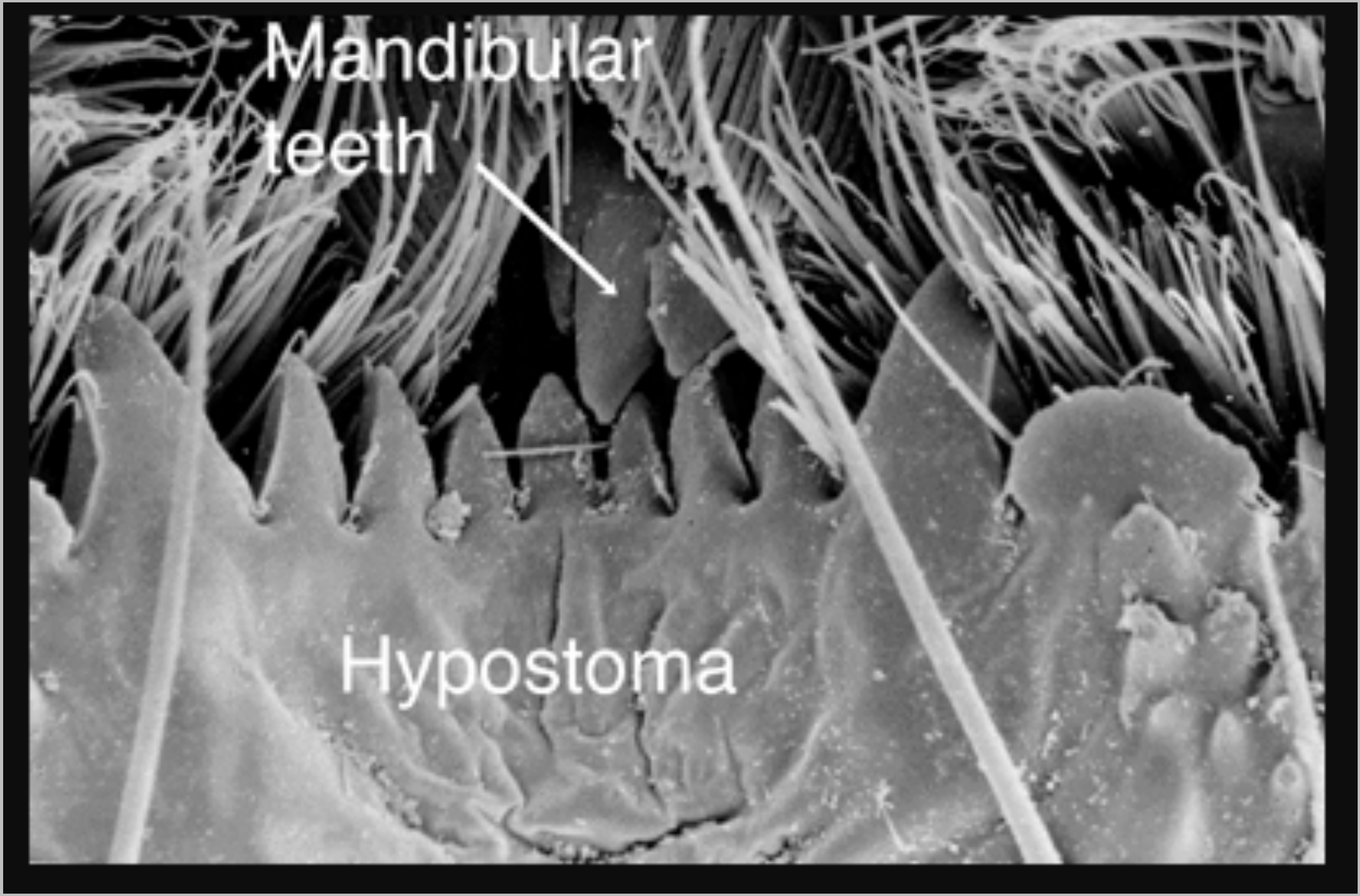

A
Flow Direction
5 cm/s
Labral Fan (F°)
10 cm/s
15 cm/s
Head (C°)
20 cm/s
25 cm/s
30 cm/s
Thorax (T°)
35 cm/s
40 cm/s
45 cm/s
50 cm/s
Relative Angle
Abdomen
(A°)
sweet
spot?



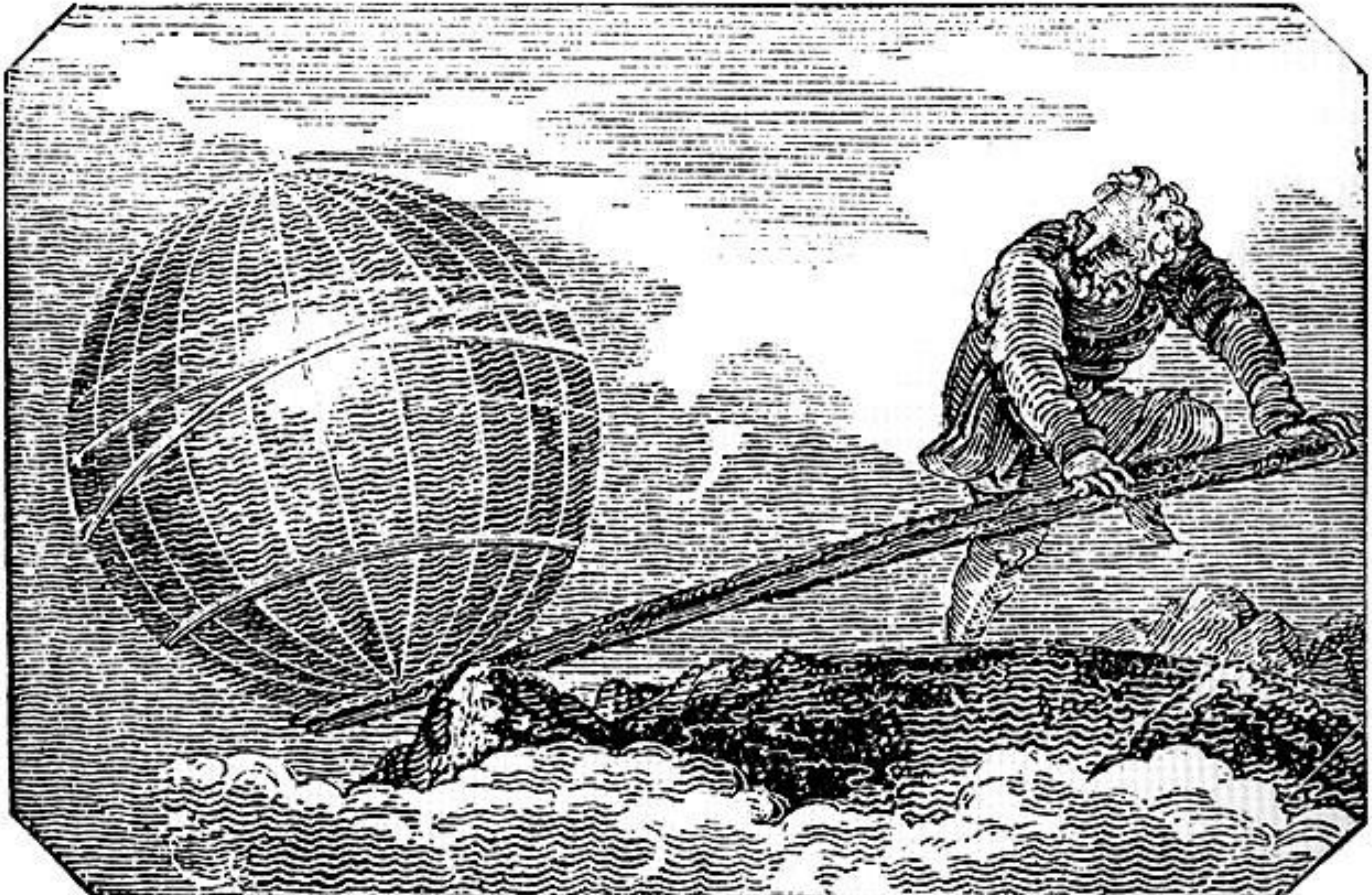

5
mnd
mxp
am
pp
mxl


ps
su
cb
ab
at
ami
pat
dpb
ppb
8



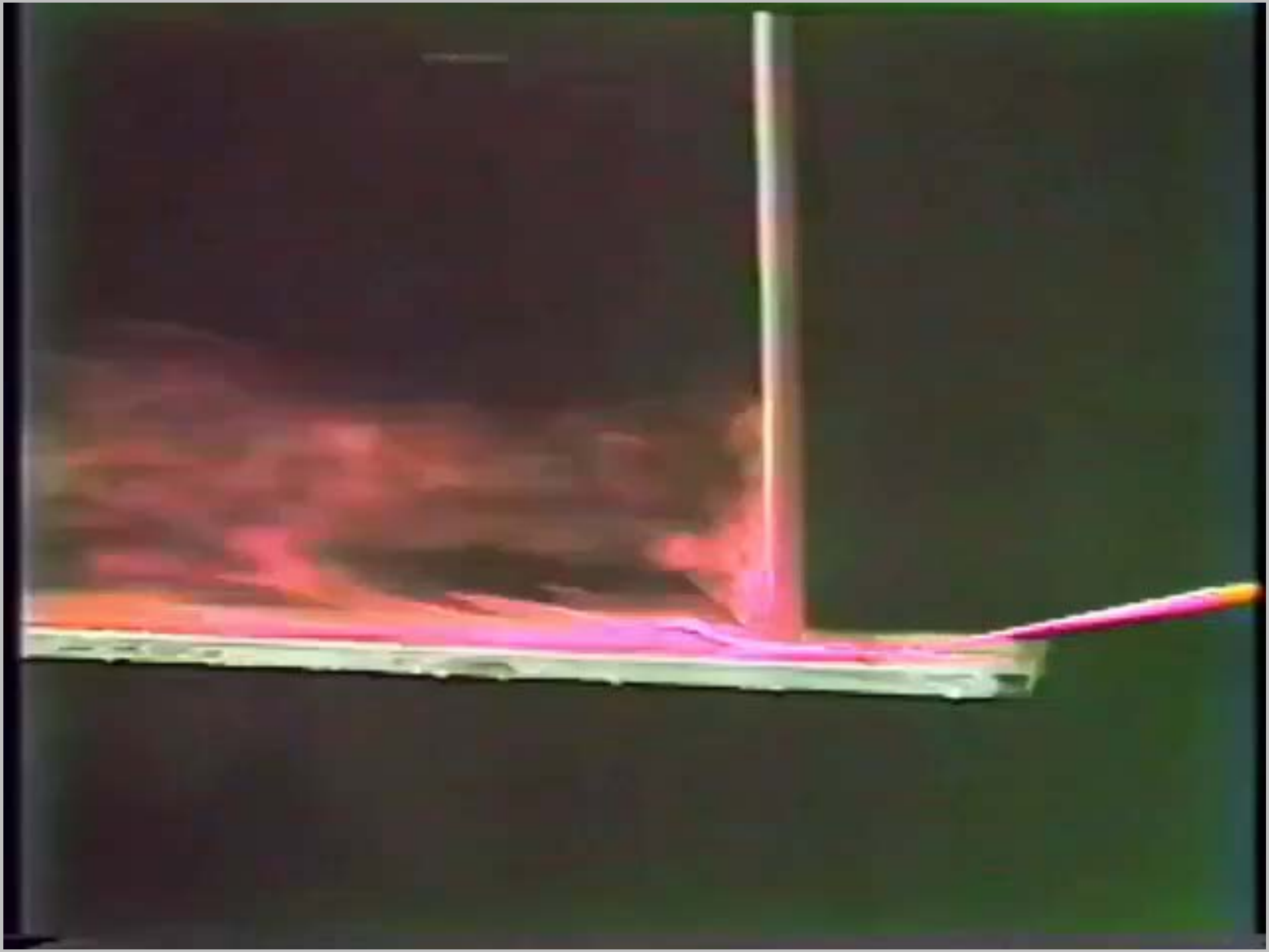

Mandibular
teeth
Hypostoma


IKEA




1.0 mm


1.0 mm



, <u>Simulium vittatum</u>

24fps. Exp. 1/216 sec.

Water vel. 13 cm/sec.

Do insects do it better than engineers?

Six of one, half a dozen of the other!

Organisms need to deal with the same physics as engineers do. However, engineers have access to materials other than cuticle – the compound that insects use to grow structures. Cuticle, however, gives insects a great deal of "flexibility".
Not only that, but insects can change their behaviour to suit the situation and have no hesitation in using a chisel as a screwdriver.

A little bit of work for you all……..

Do a bit of hand-waving yourself
on the way home…..

But watch out for traffic police and
make sure the road is clear……